Innovation or Financialization? : The Evoloution of the Systems-Integration Buisness Model at Airbus and Boeing

Mustafa Erdem Sakinç

THÈSE PRÉSENTÉE
POUR OBTENIR LE GRADE DE

DOCTEUR DE L'UNIVERSITÉ DE BORDEAUX

ÉCOLE DOCTORALE ENTREPRISE, ÉCONOMIE, SOCIÉTÉ (ED 42)

Par **Mustafa Erdem SAKINÇ**

INNOVATION OR FINANCIALIZATION? THE EVOLUTION OF THE SYSTEMS-INTEGRATION BUSINESS MODEL AT AIRBUS AND BOEING

Sous la direction de **M. Claude DUPUY** et **M. William LAZONICK**

Soutenue le 23 juin 2016

Membres du jury :

M. DUPUY Claude
Professeur, Université de Bordeaux, *co-directeur de thèse*

M. FRIGANT Vincent
Maître de Conférences (HDR), Université de Bordeaux

M. LAZONICK William
Professeur, Université de Massachusetts Lowell, *co-directeur de thèse*

M. MILBERG William
Professeur, The New School

Mme. REVEST Valérie
Maître de Conférences (HDR), Université Lumière-Lyon-II, *rapporteur*

M. TALBOT Damien
Professeur, Université d'Auvergne, *rapporteur*

Innovation ou Financiarisation ? L'Évolution du *Business Model* basé sur l'Intégration de Systèmes chez Airbus et Boeing.

Résumé : S'appuyant sur une approche comparative et historique au niveau de la firme, cette thèse étudie les dynamiques de la réussite économique à long terme de la construction d'avions civils aux Etats-Unis et en Europe. Cette analyse est menée à partir de l'étude d'Airbus et de Boeing qui sont les deux plus grandes firmes du secteur aéronautique au niveau mondial. La thèse identifie les conditions sociales qui influencent les capacités concurrentielles des deux firmes et les pratiques qui jouent un rôle sur l'amélioration ou la dégradation des capacités productives de leur secteur à travers un cadre analytique basé sur les modèles productifs / les modèles d'affaires (*productive/business models*). Les trois éléments majeurs de l'activité productive au niveau de la firme, à savoir la stratégie d'entreprise, la structure organisationnelle et le degré d'engagement financier sont analysés dans ce cadre appliqué à l'intégration de systèmes. Les résultats de cette recherche montrent qu'il existe une forte corrélation entre la sous-traitance massive, la financiarisation des stratégies d'entreprise et les relations conflictuelles de travail. L'évolution des stratégies d'Airbus et de Boeing et leur influence sur l'amélioration ou la dégradation de leurs capacités productives sont fortement liées aux transformations dans le domaine financier et dans l'organisation productive / les relations industrielles qui caractérisent les économies occidentales depuis les trois dernières décennies. Les conséquences des actions menées par les entreprises sur la promotion de l'emploi dans leur(s) pays d'origine sont questionnées et des implications en termes de stratégies d'entreprise et de politiques publiques sont tirées de cette thèse.

Mots-clés : innovation, capacités organisationnelles, financiarisation, intégration de systèmes, industrie aéronautique, Airbus, Boeing

---

Innovation or Financialization? The Evolution of the Systems-Integration Business Model Airbus and Boeing

Abstract: This dissertation analyzes the dynamics of long-term success in commercial aircraft manufacturing in the US and Europe performed through a historical-comparative methodology employed for firm level analysis. The firm-level case studies are Airbus and Boeing, the two biggest firms in the commercial aircraft manufacturing industry. Through an analytical framework concentrated on business/productive models of corporate activity, the study identifies the social conditions that influence the competitive capabilities of these two companies and their practices in upgrading, or downgrading, the productive capabilities of their respective industries. The three main elements of firm-level productive activity under modern capitalism, namely corporate strategy, organizational structure and financial commitment are analyzed through the lens of the systems-integration business/productive model framework. The results of the research show that there is a strong correlation between extensive outsourcing, financialization of business strategies and conflicting employment relations. Distinct constructive and destructive processes of corporate strategies of Airbus and Boeing are strongly linked to the role of the transformations of finance and work organization/industrial relations in the last three decades in Western economies. The consequences of corporate action on the promotion of secure jobs with positive prospects for their respective economies are questioned and relevant implications are drawn for business and government policy.

Keywords: innovation, organizational capabilities, financialization, systems integration, commercial aircraft industry, Airbus, Boeing

ACKNOWLEDGMENTS

During the slow progress of this dissertation, some people have contributed, guided and supported in it in various ways. First of all, I would like to thank my supervisors Claude Dupuy and William Lazonick, for their guidance throughout the process of planning and writing this thesis. Claude has given me invaluable comments and feedback from the early stages of my project. Bill has not only guided me from the very beginning of the project, but has also taught me how to do political economy proper. They have been very supportive mentors throughout the process of defining my research questions and writing my dissertation. I am grateful for their time and guidance. I would like to extend my gratitude to the committee members Valérie Revest, Damien Talbot, William Milberg and Vincent Frigant.

In addition to my committee, I have been quite lucky in the academic and material support I have received throughout my work. In particular, I want to thank Matthieu Montalban for his enthusiasm, detailed comments, and breadth of perspective on my research. My special thanks go to the ex-occupants of the Room F342, Ji-Yong, Caroline, Nicolas, Alexis and several coffee machines we managed to break who were all the time supportive and understanding.

Finally, at all stages of my studies, my family have encouraged and supported me. I am grateful for how strongly they believe in me. The last but definitely not least, I want to thank Antonia, who I met while I was somewhere in the middle of my thesis work (or somewhere in the middle of nowhere). Without her emotional support the dissertation writing process would certainly be much more depressing.

TABLE OF CONTENTS

General Introduction 1

First Part - Theoretical Framework, Model Building and Industrial Dynamics in Commercial Aircraft Manufacturing 21

Chapter One - Theoretical Discussion and Model Building: Innovation, Capabilities and Business/Productive Models 23

1.1 Introduction 23

1.2 Innovation as organization 24

1.3 Innovation beyond organization 25

1.4 Need for an enriched return to the analysis of the 'box' 28

1.5 Origins of capabilities discussion 29

1.6 Organizational capabilities 30

1.7 Models as theory building efforts 35

1.8 Business Models 36

1.9 Productive Models 37

1.10 Main issues of models 39

1.11 Model proposition of this study 47

1.12 The concept of systems integration 50

1.13 Why systems integration can be a business/productive model? 55

1.14 Conclusion of the chapter 59

Chapter Two - Industrial Dynamics of Aerospace and Commercial Aircraft Manufacturing 61

2.1 Introduction 61

2.2 Defense connection 68

2.3 Demand, Product Markets and Competition 70

2.4 Technological characteristics and product development 78

2.5 Industrial organization and supply chain 83

2.6 Workforce 85

2.7 Finance of the Industry 89

2.8 Government Presence 90

2.9 Conclusion of the chapter 108

Second Part - Systems Integration as Business/Productive Model of Airbus and Boeing 113

Chapter Three - 'Strategy' component of Airbus and Boeing systems integration business/productive models 115

3.1 Introduction 115
3.2 Product policy in commercial aircraft manufacturing 116
3.3 Where to find capabilities? In-housing vs. outsourcing 120
3.4 Organizing production in aerospace 124
3.5 Supply Chain 787 vs. A350 - similarities more than differences 134
3.6 Insourcing 787 vs. 350 - differences more than similarities 139
3.7 Capability development through knowledge acquisition 142
3.8 Boundaries in movement – enlarging and shrinking capabilities 162
3.9 Conclusion of the chapter 177
Chapter Four - 'Organization' component of Airbus and Boeing systems-integration business/productive models 181
4.1 Introduction 181
4.2 Elements of analysis for organizational integration 182
4.3 Historical context of organizational transformations 185
4.4 Features of organizational strength and workforce characteristics: Airbus vs. Boeing 188
4.5 Work organization in Boeing 194
4.6 Work organization in Airbus 208
4.7 Conclusion of the chapter 213
Chapter Five - 'Finance' component of Airbus and Boeing systems integration business/productive models 215
5.1 Introduction 215
5.2 Finance of innovation 215
5.3 Recent historical context of the role of finance 217
5.4 Finance of innovation vs. Finance of shareholder value at Airbus and Boeing 225
5.5 Conclusion of the chapter 244
General Conclusion 247
Appendix - The Fall of Manufacturing in the West 260
Bibliography 270
List of Tables 291
List of Figures 293
Summary in French – Résumé en français 296

General Introduction

In the wake of financial and economic repercussions of the global recession, a consensus has emerged in the developed world which claims that a renewed approach to industry and manufacturing is fundamental for economic recovery. Proposed as a cure to economic problems of the post-crisis period, the term reindustrialization is once again in wide circulation. After around six million manufacturing jobs were lost between 2007 and 2012 in the US and EU together, the US and European administrations initiated a variety of programs and proposed a set of financial support schemes and tools. Europeans also set a target of raising manufacturing share in EU GDP to 20 percent by 2020 from its current level of around 15 percent.

Indeed, the statistics over the decline of manufacturing jobs and output in the US and Europe show the slowdown of industry for almost every advanced economy of the West (see Appendix A for a detailed discussion over the extent of Western deindustrialization in the form of degrading manufacturing capabilities). There is a widening gap between public policies to preserve productive capabilities of national economies and the corporate strategies with their shifting focus on innovation and capability development activity. In effect, the accord between the government policy and corporate action that maintains high-end, high-productivity manufacturing that in turn sustain high-wage employment opportunities to keep Western national economies prosperous has been degrading for some time. On the other hand, only a combination of sound business strategy and government policy can enable the conditions to sustain high-productivity with high-wage employment opportunities.

For scholarly research, this weakening accord represented by the loss of high road jobs, faltering employment levels and slowly eroding competitiveness of Western economies calls for a renewed theoretical perspective to guide government policy that seeks to restore high value-added industrial employment with positive multiplier effects for the rest of the society. It is these jobs that support relatively high standards of living and they are sustainable over a long period of time as they mostly belong to industries that are key drivers of innovation. Accordingly, only an integrated theory of innovative enterprise can address the interconnections between the role of business enterprise, industrial sectors and institutions

(Lazonick, 2010b) to determine necessary policy recommendations for national prosperity in a globalized economy.

An answer to the question why do innovative enterprises matter to the economic prosperity of a nation should thus provide an understanding over the relevance of their productive activity for nations and societies. An inquiry into the value of an industry and its firms supporting high wages and expanding employment opportunities may eventually provide a basis for the explanations for the reasons of the loss of competitiveness in the West. Such an inquiry, in effect, should be followed with a comparative analysis elaborating different aspects of industrial activity within specific sectors, such as commercial aircraft manufacturing that is the focus of this study. The major purpose of this study is to identify the sources of competitiveness in commercial aircraft manufacturing, one of the few remaining manufacturing industries which Western economies master by far the best, in order to explore the dynamics of industrial strength and weakness. The reason for choosing this specific industry mainly rests upon the fact that thus far it has not shared the fate of many other productive industries' loss of competitiveness, degraded employment opportunities and faltering growth prospects.

Therefore, the aim of this thesis is to investigate the dynamics of long-term success in commercial aircraft manufacturing in the US and Europe analyzed through a historical-comparative methodology employed for firm level analysis. As it is highlighted above, the reason why Airbus and Boeing were chosen to be studied in detail is to shed light on the comparative industrial performance in terms of the strengths and weaknesses of these two success stories on the two sides of the Atlantic. Through an analytical framework concentrated on business/productive models of corporate activity, the thesis tries to identify the social conditions that influence the competitive capabilities of these two companies and the practices of the companies in upgrading, or downgrading, the productive capabilities of their respective industries within their geographies. The consequences of corporate action over the promotion of secure jobs with positive prospects for their respective economies are investigated and relevant implications are drawn for business and government policy.

An analysis of the multiple aspects of the widening gap between public policy and corporate action would not be complete without a discussion of the actions of the principal actor of economic activity, business enterprise. It would be an important mistake to highlight the role of government in supporting manufacturing industries while ignoring the role of enterprise in developing and utilizing productive resources. This is a mistake continuously made by industrial policy proponents who highlight the role of government investments in productive capabilities while they ignore the necessarily complementary role of enterprises (Atkinson et al., 2012, Ezell and Atkinson, 2011). When the research in this fashion claims that many non-Western and some Western governments support their industries with multiple mechanisms and coordinated action (Atkinson et al., 2012; Gaffard, 2013; Wade, 2012), it usually ignores the differences in social conditions in each country that may support or discourage corporate actions oriented towards pro-innovation, pro-skills development and pro-high-road employment that endorse the reproduction of collective and cumulative innovative capabilities. In other words, they lament the demise of manufacturing or productive activity while neglecting an analysis of the possible role of corporate resource-allocation decisions. The role of corporate decision-making in fostering or impairing industrial activity at home can only be seen through a firm-level analysis that integrates a specific theoretical framework and historical research.

Units of Analysis

Industrial strengths and weaknesses of different countries vary a great deal. Industries that are successful in the long term can only be created under conditions that have gradually evolved over time. Industrial production is the activity to transform human labor into economic value or wealth. Within the modern capitalist organization, the activity is primarily organized around business enterprises. These enterprises develop and utilize different forms of capabilities to enable the transformation of intellect and labor into value, and the main form of extending the economic and social wealth is innovation. Innovation is the historic and irreversible change in the way of doing things (Schumpeter, 1968). By definition it requires learning about how to transform technologies and access markets in ways that generate higher quality, lower cost products (Lazonick, 2005). There are countless ways of developing or activating productive capabilities which result in a myriad of forms of organizing value creation. Business enterprises represent an immense variety of organizational forms and innovative performance even though they may perform similar business activities in specific areas. In order to find appropriate answers to the issues of upgrading or worsening productive capabilities of certain firms, industries and nations, the fundamental question that should be continuously asked is: How do the value creation and the value distribution work as transformation processes within the modern business enterprise, and how do they evolve in time? If innovation is defined as the engine of wealth generation and the qualitative and quantitative development of value creation is the result of innovation, it is the corporate action that enables or disables innovation. The long-term commitment of all stakeholders, and before all, the actors who oversight strategic control on resource allocation should target fostering value creation and innovation (Lazonick, 2013). As a result, it is necessary to track the shift in corporate resource allocation and strategic control in the last three decades in specific industries and pivot firms that are key actors within their industries in order to identify the real reasons behind the loss of certain productive capabilities in the West. To give an example, if outsourcing and offshoring contribute to deindustrialization in the West as an aspect of globalization, the corporate action that favors such practices together with its reasons should be deeply investigated.

The major concern with the loss of productive capabilities is that a major part of the learning process takes place when companies move through commercialization after prototyping and demonstration, when production workforce including engineers on the shop floor collaborate with design engineers to find better solutions to identified problems. When the learning process falters, the technical expertise and skills needed to further the production process cannot be developed further for the new generation of products (MIT, 2013). The separation of innovation and production is under-studied in terms of its implications for the pool of capabilities and skills at firm and nation levels with resulting effects on employment. The impact of fundamental changes that have been spurring global manufacturing in the last two decades like the transformations in supply chains, intercompany collaborations and alliances, and the role of 'national systems' pursuing economic growth has to be analyzed beyond employment, trade or domestic policy focused analyses of industrial success and sustainable growth. The links between skills and capability development, access to innovation finance and corporate strategies promoting or undermining these processes have to be established within an analysis of competitive success of productive economies, sectors and organizations.

Accordingly, this thesis proposes an analysis organized around a business/productive model framework focused on the comparison of strategic, organizational and financial orientations of Airbus and Boeing, two pivot firms of commercial aircraft manufacturing industry of the world.

In effect, the character of the subject matter strongly entails the necessity of conceptual frameworks to construct and use in order to pin down corporate strategy, organization and finance as the fundamental elements of firm-level analysis. In any case, the usage of frameworks based on certain theoretical perspectives is critical to understand industrial dynamics and corporate actions within any specific period of time or in any specific geography.

Conceptualized with the guidance of the theory of innovative enterprise (Lazonick, 2013) and productive models framework of the Regulation theory (Boyer and Freyssenet, 2000a) in the following chapters, the thesis analyzes the systems integration business/productive model of commercial aircraft manufacturing embraced by Airbus and Boeing albeit with converging and diverging inclinations at strategic, organizational and financial levels.

The main conclusion drawn from the research around this framework is that the history of organizational success of both firms is still being written by their deliberate actions and decisions over the extent of their productive organizations. Differing and resembling features of systems integration orientation of two firms are built on their highly normative understanding of the term through varying degrees of outsourcing, integration, disintegration and internationalization in various segments of commercial aircraft manufacturing in particular and aerospace in general. In addition, the strategic decisions they take and their functional results which are sometimes controversial in different times and spaces help to identify the strong relation between knowing and doing innovation. These actions also contain the endless efforts of two firms to change their technological and industrial boundaries in order to keep their positions as the most innovative aerospace companies of their regions, if not globally.

However, these strategic orientations can only be fully understood when they are construed with organizational and financial processes these two companies simultaneously follow. These processes are also marked with important similarities and differences.

The comparative case study research of this thesis shows that the concerns over industrial relations and the protection of productive capabilities are critically important factors over strategic decisions of two firms in reshaping their map of productive capabilities. Part of their supply chain reorganizations for their latest aircraft programs, both firms extended their reach beyond advanced economies towards developing economies. There is an evolutionary process of capability development of suppliers primarily endorsed by Airbus and Boeing through their changing outsourcing and partnering strategies. However, in the case of partners from developing economies and primarily the Chinese ones, the support of their respective governments to support national aerospace capability development efforts largely complements the willingness of Airbus and Boeing to transfer more work to these emerging aerospace firms. For both firms, there is equally relevant evidence of integration and disintegration depending on the highly normative understanding of the term systems integration by these companies. Especially in investments related to soft businesses like electronics, IT or services, the definition of systems integration is highly ambiguous as both companies invest and divest in these domains simultaneously. Compared to Airbus' much more active strategy to enlarge and contract its boundaries through higher number of acquisitions, divestments and investments out of its home countries, Boeing's investment strategy is largely restricted to the US while its outsourcing is much more highlighted in terms of geographical dispersion compared to Airbus.

In both cases employment relations are strained with mounting concerns of employees over job security and long-term employment opportunities on both sides of the Atlantic. Such concerns are also expressed in the declining interest in aerospace of the potential labor force especially in the US. Conflictual relations with employees, lack of sound communication channels between the management and labor force and flexible work schemes are received with mixed reactions by the labor force of both firms. However, degrading practices of work in the systems integration period are not equally highlighted in two companies. Certain aspects of the model like leveraging over stakeholders to extract gains through managing flexibility and conflict resolution have different forms with different types of tensions created among labor force.

Nevertheless, these concerns which are expanded during the systems integration period are not equally highlighted in two companies and certain aspects like conflict resolution have considerably different forms. These differences remind the critical role of institutional structures in giving certain character to the forms of industrial relations and work organization.

Finally, financial motives are also as important as organizational inclinations in giving shape to strategic decision-making of both firms. Utilizing government support and retained earnings as the most important sources of financing innovation and value creation, these two companies have so far expressed different value extraction practices expressed in their different levels of shareholder value distribution. However, the orientation towards shareholder value maximization characterizes both firms, but is much stronger in the case of Boeing with massive amounts of share repurchases and dividend payments and the rapid rise of stock-based executive compensation in the last two decades.

General results of this research show that there is a strong correlation between extensive outsourcing, financialization of business strategies and conflicting employment relations which is critical in determining the long-term sustainability of the commercial aircraft manufacturing in these two geographies. None of the firms has an ongoing aircraft development program other than derivatives and upgrades of existing programs. This means that they are going to enter a head-to-head competition with two or more other firms in the following decade in smaller aircraft segments with their upgraded narrow body aircraft. It is the segment which they generate a great bulk of their cash inflow critically necessary to fund future development programs.

New aircraft development is the very center of innovation in commercial aircraft manufacturing. The activity defines the future shape of skill pool of the company and the national industry as long as leading companies extend their reach to other companies through partnerships. The implications for innovation of the strategic, organizational and financial inclinations of these two companies are strongly attached to the future course of aircraft manufacturing in the US and Europe. In contrast with ever-deepening government support, the social conditions of innovation in aerospace are hampered with excessive outsourcing, conflictual industrial relations and shareholder value orientation on both sides of the Atlantic. The recent history of these two companies analyzed throughout this study shows that Boeing is much less immune to the perils of financialization and shareholder value orientation with their exigencies at corporate level expressed in terms of conflictual relationships with stakeholders, especially the labor force, with long term consequences. However, the differences between the two firms are not categorical. Most recent orientation of Airbus towards shareholder value also shows that the ideas around maximization of shareholder value can easily be bought even by the most resilient European firms to financial pressures. The decisions over the productive organization expressed in terms of new product development efforts will define the future course aerospace in the US and Western Europe.

Nevertheless, commercial aircraft manufacturing still remains as the major competitive industry of the US and Europe with substantial high-road employment opportunities, extensive export revenues and prolific innovative capabilities required for the future course of human transport and space research. The conclusions of this study entail important implications both for business firms as the primary sources of productive capabilities and government policy as the age-old facilitator of the business action to develop these productive resources. The analysis has shown that the two firms are not immune to the ongoing organizational and financial transformations at the global level even though the persisting differences rest upon individual (firm-level) and national factors that support or undermine productive capabilities in the long run. The strong association of extensive outsourcing, ever increasing job insecurity and conflictual employment relations and massive shareholder value distribution offers important insights for renewed approaches to government policy. The policies have been largely focused on providing funds and other tools to foster companies' innovative capabilities. However, they have ignored mounting problems at organizational and financial levels of corporate decision making which has been rendering the ever increasing government support more and more ineffectual and unsustainable. There is a growing need to address the contradiction between the use of public support for developing next generation capabilities to produce more energy efficient, environmentally friendly and competitive products of the future, and pursuing financialized and conflictual corporate strategies.

Accordingly, in order to lay out the research framework necessary to provide answers to the problems addressed, the following section details the reasoning with the focus on innovation and productive capabilities as the foundations of economic growth. It is followed by the research design of the analytical framework, research methodology and the outline of the following chapters.

The Main Dynamic of Prosperity – Innovation

The most notable dynamic of capitalism is change. It is the most shared aspect of every capitalistic relation. Production techniques, innovative technologies, organizations, industrial relations, exchange and market mechanisms and all their supporting institutional structures are in constant change since the early days of Industrial Revolution in mid-eighteenth century years.

The primary effort of economic and social theory structured and ramified around different disciplines has long been to document and interpret this change within capitalistic systems and structures through myriad of perspectives. These efforts of enormous intellectual diversity have even generated full-fledged academic disciplines with countless approaches to the very same phenomena with remarkably intertwined analytical forms of inquiry.

Change is also decisive in the analytical rigor of these numerous economic perspectives of understanding and interpreting the dynamisms of capitalism principally as a production system. While neoclassical economics, a main line of contemporary economic research, categorically excludes any role of change in redesigning tools and mechanisms of economic activity across the world, other lines of research have been struggling to keep up with the tremendous speed of change in order to integrate it in their analytical frameworks.

As part of the second group's efforts to understand economic dynamics, this thesis identifies innovation as the primary source of constructive change in an economy. It is the main purpose of economic activity to further value creating efforts of organizations and the uppermost aim of industries to stay competitive. Equally important, it has important implications for sustaining the distribution of value created, among all the stakeholders involved in the production process. Considering the hardship for the scholarly research community to overcome difficulties to go beyond the established perspectives like optimizing firm or markets as value creators, there is a permanent requirement to keep pushing the role of innovation in value creation as well as the conditions that support or undermine these processes.

To sustain the value-creation process and to advance it through innovation can only be possible through required investments in productive capabilities. The study of innovation and capabilities should first maintain that these investments can only be designed through an organizational process (Lazonick, 2013). Any intellectual, technological or communicational process has to be embedded in certain organizational structures. Accordingly, the research agenda can be structured around the question of how these structures help productive forces of organizations including business firms to generate innovation and under what conditions they are enabled or undermined.

This question is very critical because much of the literature on innovation misses the point of systemic change which can only be elaborated with a joint analysis of strategy, organization and finance, the very enablers of innovation as an uncertain, cumulative and collective activity. Only an analysis complete enough to elaborate the sources of change at different levels of economic activity shaped by different interactions between actors can give a meaning to the constant remaking of the organization of economic activity and the relations between all the parties involved. Change is neither restricted to the technological breakthroughs along innovation, nor it is a byproduct of the most recent phenomena like globalization or financialization, causing abstract reconfigurations for analysis of the elements of productive organizations. As an example, the widening gap between financial motives and productive activity is not an abstract phenomenon happened in its own accord, but it is part of transformation of corporate strategies aiming a replacement of existing schemes of value distribution among different stakeholders built around compromises with value extraction mechanisms in profit of certain groups whether they are directly involved in the production process or not. While the change in general is still part of a natural process of industrial evolution conditioned on the emergence of new knowledge (Metcalfe and Ramlogan, 2006), the transformation of the organization of business enterprise and its priorities, and the impact of this transformation over strategies and structures charges scholarly research with the duty to go further in analytical abstractions and restricted analyses of the relation between innovation and corporate behavior.

Research Design

To capture the flow of such transformations within a frame broad enough to see the bigger picture, or in other words, to interpret these transformations within a rigorous analytical perspective, this thesis proposes a model framework to conduct the research comparing and contrasting corporate practices of Airbus and Boeing in their productive activities. The model considers the systems integration orientation of the two firms in the last two decades as the central task of original equipment manufacturers (OEMs) to maintain necessary communication and coordination of a predominantly multi-actor project from the preliminary design till customer services confronted with a tremendous level of uncertainty due to the magnitude, novelty and complexity. Their particular strategic, organizational and financial characteristics in fulfilling this task also give shape to their distinct features within this shared business/productive model around systems integration. The model framework utilized by this thesis has been developed after three years' observation and understanding of the dynamics of aerospace industry in general and two firms' activities in particular through a very large number of sources including company reports and publications, business press articles, industry reports generated by third parties, and proprietary databases providing financial, sectoral and intellectual property data over specific companies and industries at global level in order to explain what is observed within a certain logical sequence.

Also detailed in the following chapter, the proposed model is built around a three pillar analysis of productive activities of Airbus and Boeing. These pillars, strategy which allocates resources to investments in capabilities required for the firm to compete for particular product markets; organization which develops and utilizes these value-creating capabilities of these resources to generate products; and finance which sustains this process of developing products and accessing markets until the financial returns are generated through the sale of these products (Lazonick, 2012) are utilized for the detailed analysis of these two firms' actions with a focus on their last two decades in the second part of this thesis. The two-decades period of observation is tried to be extended as long as possible when relevant information is available in order to be able to document the course of developments engendered by path continuity, departure and change (Lippert et al., 2014).

The interrelationship between corporate finance, business strategy and workplace organization is a matter of debate. It is a major handicap of many industrial and firm studies which try to analyze this triangular relationship through one or two dimensional perspectives exploring the impact of one item on others. The aim of this study is to make an elementary contribution to this debate through an empirical exploration of these issues in commercial aircraft manufacturing with a focus on each three item underlining strong links among actions within each pillar. The research has shown that, in order to document twenty-first century corporate activity in advanced economies, more empirical exploration is required of the unfolding dynamics of financialization and shareholder-value orientation; business growth strategies and continuous transformation of supply chain organizations; and corporate governance change and the management of industrial relations.

The primary reasoning behind the model proposition of this thesis is to handle economic theory for a more practical use of industrial research. Theories are simplified forms of reality to comprehend it and to make sense of historical facts (Penrose, 1989 in Lazonick, 2005), and models are considered in this thesis as the means of applying theory to certain cases of empirical analysis that has to be regularly checked along the accumulation of new historical facts.

In other words, a model framework is the connecting link of theoretical perspective and empirical analysis of a certain topic which is under constant change (in this case changing industrial dynamics and corporate strategies/actions). Indeed, the study of industrial dynamics demands a permanent and sound connection between facts and theories (Krafft, 2006). It is the constant industrial evolution which requires continuously updated research on specific sectors and pivot firms. In the case of commercial aircraft manufacturing which is the specific focus of this thesis, the industry has been analyzed in great detail in the 1980s and 1990s, and after this period, with an increased focus on specific details on issues like the subsidy war between major companies, sources and impacts technological developments or changing supply chain structure. Even though such specific research is useful to capture emerging dynamics in detail, it has the potential threat to overlook the general picture of changing industrial outlook in the West and its repercussions on a wide range of topics like corporate finance, industrial relations, and changing geographies, seemingly unrelated, but in fact strongly connected issues through the constant reorganization of resource allocation among actors of economic activity. As a result, this thesis tries to embrace a more traditional approach in a Chandlerian sense to document the course of action over the last two decades of commercial aircraft manufacturing.

Accordingly, the study follows the work of Chandler (1962, 1977) and Penrose (1959, 1960) and more recently Froud et al. (2006) and Lippert et al. (2014) in presenting detailed historical accounts of business firms in action primarily in the form of a comparative case study laid out in its second part. The practical reason of comparing only two firms is the current duopoly character of commercial large-body aircraft manufacturing in the world. Methodological reason is that the case studies cope with many more variables of interest than data points (Yin, 2003) even though data points are also important for a different dimension of analysis. In the case of specific studies of innovative enterprises, these variables correspond to the social conditions of innovation that are central to the development and utilization of productive resources. These are strategic, organizational and financial conditions which may differ across nations and they certainly change in time. Thus the study relies on multiple sources of evidence explored through a comparative-historical method detailed below.

Analytical and Methodological Choices

With a restricted focus to a specific geography (two sides of the Atlantic) and a specific industry (commercial aircraft manufacturing), this thesis is a small-scale effort to document the changing dynamics in Western productive activities with respect to their role in sustaining economic growth and prosperity to their respective nations. Its analytical proposition shaped around the business/productive models framework leans on the recent approaches of the late twentieth and early twenty first centuries to understand organizational (firm) and sectoral (industry) activity embracing change as a major impetus and a testbed for analytical rigor. Its aim to explore the sources and threats of organizational success is no different than those of previous research on firms and industries performed by scholars having comparative-historical methodologies and it is a small contribution to the ongoing efforts to understand the most recent organizational and industrial dynamics in advanced economies of the world.

The sectoral choice, as it is previously stated, reflects the importance of aerospace and commercial aircraft manufacturing industries for the productive capabilities of these economies. Economic sectors are the spaces of competition between firms utilizing similar technologies, demand forms, skill sets and respective organizational structures and they reflect the economic strength of the nations in which they are rooted. The national framework also conditions certain regulatory and support structures that provide coordination and funding mechanisms which are fundamental to the success of these national industries and the firms they contain. As business firms attain higher levels of innovation and resulting economic performance, they may also seek to change the institutional structures in order to make them suitable for their updated strategic, organizational, and financial needs (Lazonick, 2012). Indeed, the differences between greater performance of some nations in certain sectors than others may help explain the institutional differences between these countries (Malerba, 2004).

Industries emerge and act within a certain institutional context built in certain historical trajectories enabling to understand how various actions fit together in a specific industry with implications for performance. As a result, a historically informed analysis of business firms may best be conducted within an industrial perspective as long as it provides an important institutional context for firms to operate efficiently and effectively (Sako, 2008). This is a critical aspect of identifying certain groups of firms in a world where technologies and markets are constantly reshaping industrial boundaries and it is usually difficult to draw strong borderlines between different economic activities to be grouped under different sectors. The role of certain industries in reshaping world economy and politics is also fundamental. As an example, the historical role of governments in promoting aerospace capabilities of their respective nations with substantial impact over the performance of these sectors in promoting national economic growth had tremendous impact over the general economic and social life in the twentieth century through the exploding growth of global air travel or the role of military aerospace in global conflicts started with the First World War.

As a result, to have a certain industrial focus is highly important, as long as it helps to form a certain analytical focus favoring a rich set of descriptive contextualization which is hardly possible at micro or macro level analyses. To this aim, Chapter Two, provides a factual analysis of aerospace and commercial aircraft manufacturing highlighting its unique characteristics and principal particularities concerning specific elements like technological level, employment and organization of value creation as a collective effort of myriad of industrial actors/firms. Again in Chapter Two, the role of government in supporting aerospace industries and firms through a large collection of direct and indirect financial support mechanisms and regulatory frameworks that facilitated the development of the industry in the first instance are discussed in the context of US and European aerospace and their top companies Boeing and Airbus.

On the other hand, for a full understanding of an industry, in its full institutional and historical context (Sako 2008), a detailed analysis of the firms populating that industry is also fundamental. Indeed, the primary unit of analysis of this thesis is the business firm and the main analytical focus is the innovative enterprise in action. The approach is deliberately centered on the organization of innovation around business enterprise, therefore, the analysis differs from the perspectives of much other research on innovation where the unit of analysis is either the R&D management of the innovative enterprise or the collective environment like networks where the innovative enterprise acts in connection with other entities, either other firms or institutions.

A firm-level analysis is also adopted in order to have an integrated and focused perspective. Integrated because the dynamics of innovation is not solely about the organization and management of R&D or benefiting from the innovation in competition with other actors. To make R&D or knowledge resources functional in order to sustain innovation and to compete in the markets, an innovative business enterprise has to mobilize critical amounts of labor and capital resources. The underlying link between different forms of resources is where the sources of competitive advantage are located. By integrating the dynamics of capital and labor into the analysis, the study tries to avoid the oversight of the underlying reasons of fostering or hampering innovation at the firm level. This is one of the main obstacle of the technology literature as well as the institutional and 'systemic' research of innovation literature. Second, the perspective is focused because it is largely reserved, to a firm-level analysis in order to limit the discussion within the field of enterprise and incorporate institutional and market dynamics as explanatory factors when necessary. The analytical choice is to start with a discussion of industrial characteristics and to continue with a firm-level analysis.

The other important reason behind the adoption of this analytical perspective is to go beyond the idea that specific types of innovation is suitable for specific types of organizations in order to highlight the fact that different strategic actions of decision-makers over the allocation of labor and capital is predominantly important for the innovation in any form. Innovation cannot be restricted solely to managerial actions to coordinate technical organization. Only an integrated perspective endorsed with a theory of innovative enterprise can search for an answer to the question how does the role of commitment of different actors, who contribute to costly and complex innovative activities function by providing and further developing their resources in the course of innovation.

The endeavor to search for answers to such central questions should be based on a comparative-historical understanding of corporate activity to establish the required relevance of theoretical framework with empirical reality (Lazonick, 2005).

Thus the principal methodological approach of this thesis is historical-comparative. Primarily focused on around the last twenty years of business activity of Airbus and Boeing, the thesis embraces this methodology in order to integrate the theoretical framework with empirical research on the actions of innovative enterprise in different times and places.

The approach is historical because it is fundamental for the theoretical framework which "requires an understanding of the historical process that is sufficiently broad and deep so that the assumptions and relations that form the substance of the theory capture the essential reality to which the theory purports to be relevant" (Lazonick, 2002). Equally important, the historical perspective is crucial to have an understanding of historical reality in order to avoid inferring categorically wrong conclusions from shorter sections of a much longer trajectory (Froud, et al., 2006). Keeping this in mind, the thesis tries to extend its focus as far back in history as the relevant historical information is found to shed light on current phenomena like continuing product development programs, ongoing employment relations or recent financial activity engaged for value creation or value extraction. The historical perspective is also practically important for the analysis of this industry considering its long-term character of committing its resources to design and build end products that can be used and maintained for several decades. The last but not least, historical method is also crucial to find out the ruptures and continuities if there are, by looking at longer periods of time when change becomes largely visible to detect. It is especially important for a firm-level analysis which reveals more precisely the many facets of change and helps to explore the details hidden in the diversity and its underlying dynamics (Lippert et al., 2014).

The approach is comparative for two main reasons. The more practical reason is because the acknowledgement of distinct firm characteristics can only be possible when the firms having these characteristics are compared with other firms. Rather fundamental reason is that in order to highlight the role of national institutional settings for the strategic orientation and performance of business enterprises, it is crucial to have an understanding of the dynamics of value-creating innovative firms of different economies. The evolution of the conditions of innovative firms and their organization and performance in different times and places can only be identified through a comparative analysis of firms and industries across nations (Lazonick, 2010b). Only through a comparative analysis one can identify the ways how productive resources in an economy are allocated differently by corporations. As an example put by Jacoby (2007); "one can understand what makes American companies 'American' only by comparing them to companies elsewhere in the world that operate under different rules of the game". To investigate how do different national institutional settings induce differences in corporate strategies and structures, an explicit comparative study focused on specific industries and firms is essential (Sako, 2006). Empirical studies investigating differing R&D and growth dynamics in the US and EU address the policy differences characterized by distinct institutional foundations creating varying outcomes (Castello, 2010; Crescenzi, et al., 2007). The last but not least, the comparative analysis of actors belonging different institutional structures also permits to identify converging and diverging practices of corporations under the impact of same phenomena like globalization, increasing value chain activity or technological breakthroughs within the industry in question.

Thus the continuous interaction of firm specific organizational dynamics and geography specific social conditions provide important insights for a comparative analysis to explore evolutionary trends in the commercial aircraft industry shaped by strategic decisions taken by major firms like Airbus and Boeing.

Although it is beyond this thesis primarily due to the structural reason that only one firm exists in each geography in commercial aircraft manufacturing, another intellectual activity can be to identify differences among business firms belonging to the same industry in the same country through an in-country comparative analysis. Even though they are subject to similar technology and market related pressures, these companies may exhibit distinct strategies and varying performance outcomes owing to their different capabilities to cope with challenges of productive and market activity (Nelson, 1991; Sako, 2008).

Sources of Data

Although there is substantial academic and non-academic literature on the historical and technological evolution of the aircraft industry, little has been written from the viewpoint of business/productive model comparisons of major aerospace companies of the world. The research on industry is mainly composed of separate accounts focused on specific companies with a much heavier weight on Boeing. Limited number of non-academic studies comparing business strategies of and competition between Airbus and Boeing are far from providing detailed accounts of strategic, organizational and financial inclinations of two companies in the last two decades. On this note, the empirical findings for this research are based on several different information sources:

- A big range of quantitative information created through the collection of data from primary sources like companies' annual reports, and industrial, intellectual property and financial databases.
- Information collected from the websites of companies, industry journals and other media sources providing industry specific news and reports.
- Published material from industry associations and government agencies.

The main difference between this research and many other inquiries of commercial aircraft manufacturing is that this study presents an integrated account of two major aerospace companies through a comparative perspective. It focuses on every aspect of corporate activity related to the sustainability of innovative performance as well as potential threats undermining innovative enterprise character of the two firms. These two firms provided the milestones of air transport in the last decades while many other aircraft manufacturers were eliminated from the world market during the same period.

Outline of the Thesis

This thesis is structured in two parts. The first part lays out the general theoretical perspective proposed for the analysis and the industrial level discussion. The second part discusses the last two decades of Airbus and Boeing through a comparative methodology with a focus on their strategic, organizational and financial orientations during their latest aircraft development programs which are still running with derivative options.

In the first chapter following this introduction, a theoretical framework is proposed for the analysis of the sector and the two firms around the discussion of business/productive models. After a brief discussion of innovation and capabilities within the innovation literature, the use of models is discussed as bridges between theories and empirical studies. Following, the productive models perspective of the Regulation school and the discussion of business models within the business literature are presented in order to help create the analytical methodology of the study. In the last part of the chapter, the orientation towards systems integration is introduced as the dominant model of doing business in commercial aircraft manufacturing. The history and the current discussion over systems integration are also presented.

In the second chapter, the study takes an industry-level approach in order to analyze the most important elements of aerospace and commercial aircraft manufacturing. Such an analysis is fundamental to reveal the major dynamics of the industry and its future course to be highlighted with increased competition. Product markets, technological characteristics, industrial organization of aircraft manufacturing, particularities of the aerospace workforce, and the finance of the industry are main headlines that are elaborated throughout the chapter. Due to its crucial importance for the development of the industry and its ongoing activity, the role of governments through a wide range of financial and non-financial support mechanisms deserves a bigger section dedicated to a historical analysis of government presence at the end of this chapter.

Following the industrial level discussion, the following three chapters are dedicated to the comparative analysis of Airbus and Boeing shaped around the proposed business/productive model methodology. Structured around the discussion of changing productive organization via their latest aircraft programs, each chapter elaborates one pillar of the model framework, initiated with a general discussion of the pillar and the business action that gave shape to its historical course in the last decades. The focus of Chapter Three is the changing business strategies of Airbus and Boeing and their dynamic boundaries marked with both capability enlarging (investments in innovation) and shrinking (divestment and increased outsourcing) actions along their latest aircraft development programs namely Boeing 787 and Airbus A350. The focus of Chapter Four is on the organizational aspect of these two firms' business/productive models. Their work organization is compared and contrasted with a discussion of the marked events of industrial relations and organizational restructurings.

Finally, Chapter Five is focused on the finance component of the business/productive model framework and discusses the approaches of two firms in terms of sources and uses of finance during the financialization era marked with shareholder value maximization. Finance of innovation and finance of shareholder value maximization at Airbus and Boeing are compared and contrasted. In this chapter two companies' shareholding structures are also compared and the functions of stock market are elaborated from the perspective of these two companies.

First Part

Theoretical Framework, Model Building and Industrial Dynamics in Commercial Aircraft Manufacturing

Chapter One

Theoretical Discussion and Model Building: Innovation, Capabilities and Business/Productive Models

1.1 Introduction

Since its early-twentieth century definition as the source of economic development by Schumpeter who extended its scope beyond the narrow conceptualization of technological progress, innovation became a buzzword for anything about growth, prosperity, social welfare or economic policy. Any reform initiative to alter existing structures of social organizations or to launch new undertakings is today labelled as innovative activity whether it is involved in economic activity or not. For Schumpeter who coined the term, innovation is the historic and irreversible change in the way of doing things (Schumpeter, 1968). It is central to the process of economic development and it is the key driver of economic growth. It is the only means to create new sources of value in order to produce higher quality, lower cost products than those had previously been available (Lazonick, 2013).

In modern capitalism the prime generator of innovation and resulting economic development is the business enterprise. Documented and theorized all along the twentieth century by prominent scholars including Marshall, Schumpeter, Penrose and Chandler, modern business enterprise emerged as the universal model of organization for value creation without ignoring the nuances formed by different geographical, political or legal origins throughout the last century up until this day. The evolution of the small scale value creating activity of early capitalism into full-scale enterprise is itself a novelty in the form of industrial innovation characterized as one of the major forms of innovation by Schumpeter (1968). Thus, an inquiry on the role of innovation in economy and society cannot be separated from a broader understanding of modern business enterprise. It stays as the perpetual objective of value creating organizations while any other business strategy or corporate action may eventually change over time. In effect, the social conditions affecting innovation may also change over time and vary across productive activities. This change also includes the transformation of the business enterprise and its ambitions. For the sake of analytical rigor, any theoretical analysis of the innovative activity must be integrated with historical study (Lazonick, 2002).

1.2 Innovation as organization

There is a symbiotic relation between the process of innovation and business organization which provides them with the ability to have impact on each other's evolving forms and structures. The twentieth century history of innovation is a chronicle of the emergence and diffusion of different organizational forms of productive activity and their corresponding management forms. However, this symbiosis has also been the source of a major disaccord between scholars of innovation in terms of the decisive power of the one on the other. While some studies set sail for technological determinism in the name of the potential influence of innovation over the form of organization, some others are much more cautious. Nevertheless, organizational issues of innovation at the firm-level is interestingly the most ignored section of innovation studies and especially the ones in economics. The thematic focus on organization or firm is basically left to business scholars (Fagerberg et al., 2012) and the direct links between the organizational or firm-level issues of innovation and its role in economic and social change in general are not established at least as a major research field within innovation studies. For example, while the Oxford Handbook of Innovation devoted a complete section to the process of innovation at organizational level (Fagerberg et al., 2005), in a sizeable collection of works on innovation titled Handbook of the Economics of Innovation (Hall and Rosenberg, 2010), there is no main section dedicated on the organization of innovation. One single chapter on the firm, written by D. Teece highlights the role of business enterprise as a distinct actor of technological innovation.

Whether the link between a theory of the firm and a theory of innovation has not strengthened, for almost half a century, the general discussion over the sphere of innovation stayed within the business enterprise as Schumpeter defined it as a business activity. Starting with the 1970s, the role of institutions was also respected (Freeman, 1974, 1995; Mowery and Rosenberg, 1989). In effect, the idea of the interaction between technology and institutions is not new. As early as 19th century, K. Marx highlighted the role of technological dynamism which is directly associated with the historical emergence of capitalist institutions. It was the capitalist classes who were the principal defenders of technological change as their interests are firmly connected to it (Rosenberg, 1982).

In the following years, its main features were stylized by scholars (Hall and Rosenberg, 2010; Lazonick, 2005; Nelson and Winter, 1982; O'Sullivan, 2000; Rosenberg, 1976; Teece, 1996). For the use of business activity, the most pertinent ones are its uncertain, collective and cumulative natures (Lazonick, 2005; O'Sullivan, 2000). Indeed, the organizational dynamics usually frame the scope and the content of innovation for the same general aim of economic development. However, with the integration of different perspectives in business organization for the discussion of innovation by technology scholars; its general features are increasingly characterized by different actors and different types of organizations at different levels. The claim is that the growing diversity of organizational forms of business firms and their linkages formed with other organizations may have a great impact over the direction of innovation.

1.3 Innovation beyond organization

As a result of the diversifying agenda of innovation research, beginning with 1990s, scholars of industrial and technological change started to discuss the aspects of innovation by questioning the borders of business enterprise. Inspired by Williamson's (1975) discussion over the forms of organizations, Teece (1996) claimed that the formal and informal structures of the firm, together with its external links drive the strength as well as the kind of innovative activity of the business enterprise. Different organizational forms like vertical integration or conglomerates or *archetypes* in his words address the type of innovation that they can support the best. For example, an autonomous innovation, where a novelty can be introduced without modifying other components or items of equipment, better corresponds to alliances or other dynamic structures like Silicon Valley type forms. A systemic innovation, on the other hand, requires significant readjustment to other parts of the system and an integrated organizational structure which keeps the entire process under control facilitates innovation better as long as the required capabilities exist in-house (Teece, 1996). It is the nature of the flow of information between the actors of innovation which designates the suitable form of organization for a specific type of innovation and potential coordination and intellectual property issues forces companies to choose between different forms (Chesbrough and Teece, 1996).

Inspired with the assessment of the symbiosis or the interdependence of technological and organizational innovations by Chandler, Pisano (2010) also highlights the role of the design of appropriate organizational, managerial and institutional forms on the potential of innovation. As an example, science-based sectors need new models and new institutional arrangements incorporating both technological and organizational innovations and the potential of innovation can only be realized through these new appropriate forms.

Another discussion over the structure of innovation is on the means of benefiting from innovation. In their focus on the sources of industrial leadership as the translation of technological expertise into commercial success, Mowery and Nelson (1999) emphasize the systems character of organization beyond firm-level dynamics to facilitate innovation and resulting economic performance which also help to explain the factors behind national differences. Leading firms of specific industries not only benefited from their first-mover advantages and individual organizational strengths in Chandlerian sense or they solidified competitive advantage through their own investments and learning efforts in the Schumpeterian sense. They have also benefited from their national institutional and policy environments. Teece (1986) in his earlier work emphasized the same issue in a restricted level within an appropriability regime which is about the external factors including the nature of technology (putting it outside of a firm structure); the efficacy of legal mechanisms of protection; a dominant design paradigm which determines the maturity of the technology and the stage of competition (from design to price); and complementary assets needed for successful commercialization which were seen at that time out of the center of the innovativeness of a business organization. Following, industry architectures have been proposed by business scholars as an upgraded level of appropriability analysis to explain the creation and appropriation of the returns from innovation (Jacobides et al., 2006). These architectures are sector-wide mechanisms to benefit from innovation by providing the framework in which business actors interact. Businesses' ability to create architectural advantages also defines the level of their value appropriation from their or others' innovative activities.

Such efforts of explaining industrial success based on technical progress through the organization of innovation beyond internal mechanisms of business firms have also been put within a 'systems' perspective. These approaches see innovation as a collective work of rather distinct actors both organizationally and institutionally. The "national innovation system" approach highlights the roles of different actors including financial institutions, government agencies, universities, and even different occupational actors within business organizations in fostering innovation within national boundaries (Freeman 1995). The sectoral system of innovation approach also embraces the idea that innovation is a collective output of a set of different agents interacting with each other for the creation, production and sale of sectoral products (Malerba, 2004). Stressing the role of knowledge and technology together with their dynamic nature as a building block of these systems, the emphasis is on the activation of virtuous cycles of innovation and change through the coevolution of different elements of these systems.

Another influential line of recent research on innovation is the open innovation literature. It highlights the linkages between different actors or simply whether the innovation takes place only inside the boundaries of firms or in collaboration with other firms or non-firm actors. Different than systems approaches, the open innovation discussion mainly takes place within the sphere of the firm. It is proposed as the antithesis of the vertical integration model where the generation of innovation through internal research and development, the production and the distribution are all integral to the firm (Chesbrough, 2006). In the open innovation model innovation is generated within and outside of the borders of the firm and its benefits can also be shared by all the actors involved. The distribution of knowledge which can easily transcend the borders of a single firm forces business organizations to set up linkages in the form of joint ventures, alliances, networks, spin-offs, in-licensing and out-licensing at different stages of the development of technology which embodies knowledge. Teece (1996) on external linkages, Mowery (1988) on joint ventures, Langlois and Robertson (1995) on networks are some examples. Firms following the open model in comparison to so-called old vertical integration model benefit from the development of transactions along with technological development, easier access to knowledge and the development of intermediaries for knowledge exchange.

In effect, the boundaries of the firm discussion and the impact of changing boundaries on innovation is not new. Together with the rise of inter-organizational business relations which include innovative activities like joint R&D, there has been an effort to develop a chronological order for the locus of innovation. Mowery (2009) highlights that many of the elements of this (open innovation) model are apparent in the early development of US industrial R&D when larger firms monitored innovation outside of their boundaries and formed collaborations with other firms and universities; extending the definition of markets to the relations including the ones with 'firm-like' characteristics. From an institutional perspective, Langlois (2003) emphasizes that the contemporary productive organization with important implications on innovation is shaped by open modular systems of the current 'vanishing hand' period following the 'visible hand' of the vertical integration model offered by Chandler for the twentieth century capitalism.

1.4 Need for an enriched return to the analysis of the 'box'

Another important discussion over innovation is about the sharing of the benefits of innovation or the balance between the risks and rewards. Previous discussion over capturing the benefits of innovation by different actors considered firms composed of professionals as a unified group with common interest (Jacobides et al., 2006; Teece, 1986). This has left the question over the distribution of the benefits among the actors of the same entities unanswered. A parallel analysis over the question who benefits within the firm, after the firm itself benefits from innovation remains unaccomplished (Lazonick and Mazzucato, 2013). The impact of business organization's orientation over the ways in which rewards are distributed is strictly connected to the long-term success of the innovation and its benefits for the entire society. In other words, as important as the creation of value through innovation, its distribution of the gains from innovation is central to the long run sustainability of the prosperity and growth generated by innovation. Indeed, the decision over the distribution of the value created through productive activity and innovation depends on the positioning of the actors to extract more or less value than what they contribute. The imbalance between the actors who take the risk and the ones who reap the rewards of innovation has important implications over the productive capabilities of economies and their actors in the long-run (Lazonick and Mazzucato, 2013).

Thus the real strong link between innovation and organization can only be established through research on innovative enterprise with respect to a risk and reward dichotomy. Starting with the basics, the initial question is how do firms construct and coordinate complex systems of innovation and how do they coordinate an innovative project? A preliminary answer can be found in the "capabilities" perspective by leaning on the insights into the operation and performance of the innovating firm developed by scholars in the past three decades (Lazonick, 2013). A discussion over the origins and the development of capabilities perspectives may also help to identify the principal actors who take risks by putting their efforts in developing these capabilities to generate value through innovation and productive activity. Provided by productive actors, capabilities in general and organizational capabilities in particular are the transformers of innovation into value within a business organization.

1.5 Origins of capabilities discussion

To construct his perspective on innovation and economic development, Schumpeter leaned on a profound understanding of economic theory. From a perspective alternative to the mainstream view of firm and its organizational dynamics which was also cultivated by Schumpeter (1968) in the first half of the twentieth century; Chandler and Penrose, the two most prominent scholars of business organization, rightfully saw the sources of innovation and development within the business enterprise and the way how it is managed and analyzed the running of firm with their detailed empirical analyses (Chandler, 1962, 1977, 1990; Penrose, 1959, 1960). Their skepticism of mainstream explanations of economic growth and industrial organization of the day guided them to stay away from ahistorical accounts of business organization and economic growth.

Their analogous work led up to a large array of perspectives within economics and business research. One important concept which occupies a large space within this research and a key notion in structuring the theoretical understanding of this study is capabilities. They are firm-specific enablers of innovation and the development of capabilities specific to business organizations is fundamental to establish the link between innovation and productive organization.

In her seminal work Penrose (1959) defined firm as the collection of productive resources for the production and sale of goods and services for a profit. Physical, humane, cash, managerial or entrepreneurial, these resources are not only used for productive activity but also to create new productive services and to plan further expansion. Growth is a creative and dynamic interaction between a firm's productive resources and its market opportunities (Pitelis, 2009) and it is an integral aspect of the nature of firm. It is performed through a continuous search to take full advantage of opportunities for expansion and innovation as the introduction of new combinations of resources (Penrose, 1959).

Chandler's subject was also the firm. Without any restriction imposed by a theoretical focus (Teece, 2010a), he analyzed the emergence of the large industrial corporation and the role of organizational transformations in different sorts of 'economies' which constitute the development of productive resources. Nevertheless, his narrative of the firm and the focus on its role in resource allocation in an economy render his work fairly Schumpeterian (Lazonick, 2010a). His analysis on innovation has a systemic character. Innovation, in his perspective, cannot be separated from the context in which it occurs (Chandler, 1977). Thus his analysis on the rise of business enterprise as the center of productive economic activity takes an integrated approach in which technological, organizational, managerial, institutional, administrative, legal, financial or even statistical/accounting innovations act in a way that they complement each other as missing pieces of a puzzle (Chandler, 1977). They may be faster or slower than each other or they may appear in a sequential order but at the end, they all contribute to the shaping of modern business enterprise as the primary element of value creation.

The foundations laid by Penrose and Chandler provided a new perspective on organizational theories and strategic management. The ideas presented in their seminal works later extended and used by a large number of economics and business scholars. The concepts of strategy, structure and resources evolved in different directions. In the meantime, new concepts including capabilities emerged and they also evolved.

1.6 Organizational capabilities

There is a considerable discussion of capabilities by scholars who search for the links between the growth, innovativeness and profitability of firms and their organizational structures. Even though the terminology used by scholars differs because of their different conceptualization based on different combinations of theoretical perspectives they utilize, the Schumpeter-Penrose-Chandler triangle is in general the common framework they lean on.

A very early discussion of capabilities as the sources of competitive advantage is found in Learned et al. (1969). Cited in Teece et al., (1997):

> *"The capability of an organization 'is its demonstrated and potential ability to accomplish against the opposition of circumstance or competition, whatever it sets out to do. Every organization has actual and potential strengths and weaknesses; it is important to try to determine what they are and to distinguish one from the other".*

Apart from the industry level discussion of capabilities by Richardson (1972) highly influenced by Penrose's views, the first elaborate discussion of capabilities is in Nelson and Winter (1982) as part of their theory building efforts of the research on economic change. Even though they do not explicitly define organizational capabilities, they categorize them as the abilities to perform and sustain *routines* which are of 'habitual reactions' connecting the members of an organization to one another and to the environment. There is an inductive reasoning here. As an organization's capabilities require the exercise of individual skills of these organizational members, the characteristics of organizational capabilities are structured by the individual skilled behavior.

Following Nelson and Winter (1982), after a relatively dry period of 1980s considering influential research on industrial and organizational dynamics within the heterodox literature of the firm, 1990s started with a rich set of publications on organizational capabilities.

It was again Chandler (1990) who elaborated the first the concept of organizational capabilities by the empirical analysis comparative development of the large industrial corporation in the West. In his view, the fundamental motive behind the industrial success interpreted in terms of 'economies' of scale and scope resides on knowledge, skill, experience, and teamwork as the 'organized human capabilities to exploit the potential of technological processes' (Chandler, 1992). It is these capabilities that provided firms with the basis for their competitive power. In his view, capabilities are developed via cumulative learning while exploiting these economies which utilize resources. The continuity of the learning process defines the sustainability of the competitive advantage.

Another key point with the role of capabilities is the integration issues of business firms. In Chandler the decisions over integration or disintegration are explained as answers to specific market and technology situations while an enterprise aims on growth through utilizing its competitive advantages created by coordinated organizational learning and the desire to develop new ones. Accordingly, any cost calculation becomes arbitrary if the specific skills and capabilities which are either in hand or can be developed are not considered.

Accordingly, learned organizational capabilities of industrial enterprises of a nation mirrors the competitive strength of it and the differences in organizational design and governance give insights to industrial success or failure. (Chandler, 1993). In his historical account on the rise and fall of American managerial capitalism richly elaborated previously by Chandler (1977), Lazonick (1990a) defined organizational capabilities from the perspective of production process as 'the power of planned and coordinated specialized divisions of labor to achieve organizational goals'. The coordination is necessary to integrate knowledge in a collective manner to achieve necessary economic performance represented in faster flow of work and lower unit costs. The utilization of cognitive, R&D and even marketing capabilities to activate organizational ones to work with the help of necessary managerial structures was the source behind the success of American capitalism in the twentieth century. Equivalently their erosion in the second half of the century starting with shop-floor capabilities and later the managerial ones put American competitive advantage in a difficult position beginning with 1970s (Lazonick, 1990a). Indeed, the respond of the US firms to the rising international competition was to acquire other businesses instead of investing in their own capabilities. Another respond was to contract to core capabilities (Chandler, 1992).

In the turbulence of the substantial changes in corporate management and corporate culture Prahalad and Hamel (1990) proposed the core competencies approach which became widely popular in the years ahead especially among corporate executives and business consultants although in a controversial manner that the 'focus on core' was fed into the trend of downsizing or outsourcing. The approach of Prahalad and Hamel is rather different from the capabilities approach which were being developed in parallel. Their approach directly addresses the corporate executives of the period who were under great tension due to the tough Japanese competition of the period which put many Western industries in difficulty. Competencies are directly expressed in terms of core products which give their producers necessary competitive advantage even though they are not always the end product manufacturers. Nevertheless, the authors share similar perspectives with the organizational capabilities literature in the sense that core competencies are about the collective learning in an organization. They provide firms with the abilities to coordinate different skills, to maintain involvement and commitment of people, and to organize the delivery of value to customers but they are not only abstract or cognitive. They are tightly attached to the core products of firms that their production has to be kept in-house. Widely acknowledged by executives in the 1990s also because of its easy to understand ‘test’ and ‘listing’ logics to identify what is core and what is not within a corporation but with skipping the stress on the role of commitment and long-term planning highlighted by the authors, major companies of the world started to announce lists of their core competencies which would have been reviewed in the following years with or without concrete reasons. Business lines which are not on the list are considered the ones to be discarded and core competencies became an excuse to outsource anything considered not ‘core’ (Londsale and Cox, 2000).

The reason behind the differences in firm performance during the period was a compelling subject to inquiry. In his seminal paper, Nelson (1991) searches for answers for the sources of inter-firm differences. Arguing the organizational differences as the root cause of differences among firms, core capabilities in the form of abilities to generate and gain from innovation are the source of rather durable differences among firms. From his evolutionary perspective for the conditions of economic progress, firm diversity is fundamental. Contrary to the neoclassical understanding of perfect competition and trivial firm differences, it is this diversity which creates the conditions of economic progress which necessitates ‘changes’ in the Schumpeterian sense like shifts in resource allocation or the creation of new organizational routines based on new skills. For example, the success of certain routines and technology selection embedded in manufacturing methods are expressed in the differences between firms or even between different factories and projects which are resulted in divergent performances in productivity (Fujimoto, 1999; 2012).

Descriptions of capabilities are also available in the search for organizational explanations for a definition of the firm. Following resource-based perspective views, Kogut and Zanders (1992) try to explain the productive activity as the mobilization of *inert* resources or capabilities. The decisions over the selection of capabilities to keep and to develop are structured by the current knowledge of the firm and the future expectations of the economic gains from exploring new technologies and new organizing principles. These decisions are determined by the ability of learning specific capabilities and again capability differences among firms have prevailing effects on their performance. The road to growth is achieved by mobilizing knowledge with relevant organizing of social relationships inside the firm.

In the search for the sources of competitive advantage and its sustainability, the focus on firm-specific features led some scholars to look for an answer to the question, how these features in the form of competences and resources can be developed and protected in order to maintain and sustain competitive advantage (Teece et al., 1997; Teece, 2009). These scholars redefined the concept around the term 'dynamic capabilities' in order to highlight the focus on the productive activity of firms under rapidly changing technological conditions and competitive environment. With the emphasis on path dependencies and existing market positions of firms, the idea of dynamic capabilities is proposed to identify the paths, positions and processes of firms to explain their distinctiveness and inimitability. The unit of analysis, in that respect, is not the firm as a social organization but these processes and positions/patterns where the competitive advantage breeds. Research in areas like R&D management, product and process development, technology transfer, intellectual property, manufacturing, human resources, and organizational learning are integrated into the analysis but they are relevant only if they help to explain the identification of capabilities and skills for competitive advantage. The stress on building and retaining capabilities in-house is still critical. Organizations should not risk their future by focusing extensively on alliances and decentralization (Chesbrough and Teece, 1996). Indeed, dynamic capabilities require 'long-term commitments to specialized resources' by nature (Winter, 2003) that the potential to manage and sustain certain productive activities including product development necessitates the continuity of the supply of resources either they are in the form of engineering knowledge or physical assets like facilities and equipment.

Within this economics and business literature, the discussion over capabilities remains abstract even though it is channeled into a divergent set of prescriptions and analysis. It is not observed any extensive attempt to develop a new theory of the firm and a common research framework which may be based on this rich set of literature of resource based, evolutionary, behavioral and organizational views as an alternative to neoclassical perspectives on the firm. Even though there is a considerable deepening of the research over the sources of competitive advantages of firms and the general agreement that they are generally based on firms' genuine competencies and capabilities whether they are usually temporary (Collis, 1994), the wide variety of theoretical underpinnings which provide inputs to these capabilities frameworks renders building an applicable theory of the firm fairly impossible. The growing literature including empirical work on Teecian dynamic capabilities perspectives and Porterian framework of competitive advantage as two fertile grounds among these perspectives has not so far evolved into an effort of building an economic theory of innovative firm. Envisaging the strong connection to theory building, a research framework based on certain models can still be a valuable effort to reestablish the broken link between empirical analysis and theory building.

1.7 Models as theory building efforts

One reason for the lack of a common research agenda on business firms is that economics and business literatures interpret business strategy and action through a big variety of analytical frameworks containing rather distinct features shaped by different motives and interests. Similarly, the growing literature on business models contains a very large number of propositions structured by the emphasis on distinct parts or aims of productive activity. In addition, the research of economists and sociologists on productive models by the French Regulation School also offers important insights over the practices of industries and business firms which compose distinctive patterns over a certain period. A discussion over these 'models' perspectives can be helpful to identify the elements of similarities and distinctions to propose an integrated research framework for this study.

Before a discussion on the variety of business/productive model definitions with their distinct forms and functions, a clarification over the 'model' concept is needed. In essence models are abstract representations of a structure or a system. Boyer and Freyssenet (2000a) provide a list of ways in which a model is articulated in social sciences. It can be *an ideal* to be attained; *a set of attributes* to firm performance; *a methodological construct* to estimate the coherency of theoretical arguments over firm performance; and *an ex post articulation of change* along with its roots and outcomes. Similarly, a business/productive model can be approached from several different aspects identified by the analytical point of departure. The coherence between the purpose of models and their conceptualized functioning defines the boundaries of any model proposed. Again Boyer and Freyssenet (2000a) highlight the context of the identification of a model as a response to new questions of economic profitability and social acceptability which are inherent in previous models' dynamics as well as in the transformations of competitive, macroeconomic and societal contexts either at national or global levels. In this fashion;

> *"An approach identifying this sort of model should be substantive (describing the contents of the practices), historical (identifying the problems faced so as to understand what the practices actually mean) and analytical (process of building the firm's profitability through the creation of a modicum of external relevancy and internal coherency for the changes)"* (Boyer and Freyssenet 2002).

Such a methodological proposition to analyze productive activities within a model context resides in these scholars' broad understanding of the functioning of capitalist economies developed through the Regulation School's long efforts to shed light on underlying forces of capitalist development and change.

1.8 Business Models

Every important analytical concept or theoretical discussion emerge within a historical context representing a change of structures and forms including those of productive activities. The emergence of the business model concept also overlaps with shortening product lives, rising costs and increasing complexity of innovation and its organization (Chesbrough, 2007); changing ways of profiting from innovation (Teece, 2010b); as well as the rising importance of information and communication technologies and more generally of the 'new economy' together with the emergence of new industries, new professions and new sources of potential revenue also due to regulatory and institutional changes all over the world (Rédis, 2007). Thus the rising complexity of the economic environment not solely due to technological developments but also the institutional transformations on a global scale, brings about the questioning of the sustainability of existing business forms and actions.

Contrary to Porter's (2001) early warning of the blurring character of the term spread through the internet bubble of late 1990s, the business model idea was quickly embraced by the literature with an aim to highlight the role of emerging technologies in value creation and capture process (Chesbrough and Rosenbloom, 2002; Mahadevan, 2000; discussed in detail in Zott et al., 2011).

Following the slowdown of e-business fervor of early 2000s which helped the misuse of the term that bothered Porter to vanish pretty quickly (Magretta, 2002), the literature has expanded in an unfolding and deepening way. It started to include a big variety of old and new perspectives, tools and concepts of business and strategy literature while the definitions and points of interest remained divergent. It can either be a tool to mediate between technology development and economic value creation to help firms find their way in the face of rapid technological change through different functions articulating, defining and describing the value proposition, value chain and the position within the value network (Chesbrough, 2007; Chesbrough and Rosenbloom, 2002). Or more simply it can be an abstraction of the strategy of a firm (Seddon and Lewis, 2003); a set of choices on how to mobilize internal and external resources and capabilities in order to generate revenues (Lecocq et al., 2006); a system of interdependent activities in a networked form that transcends the firm itself (Zott et al., 2011). In more elaborate definitions it can also be an apparatus to conceptualize and run the logic to create and deliver value to customers in exchange of profits (Teece, 2010b); or a mechanism to generate financial surplus through a network of information always channeled to the focal entity which is the business corporation (Haslam et al., 2012). Despite the limited effort to provide a framework based on early theoretical works on business strategy coming through industrial organization or resource-based perspectives (Morris et al., 2005) and the abundance of definitions and conceptual propositions, the subject remains theoretically underdeveloped and hardly distinguishable at a conceptual level from other business organizational forms continuously being used by business and economic literature (Teece, 2010b; Zott et al., 2011).

1.9 Productive Models

On the contrary, the productive models approach of Boyer and Freyssenet provides a much more rigorous explanation of value creation or in a loose way ‘business enterprise at work’, with a solid theoretical background. In their own words a productive model is defined ‘by the conjunction of a profit strategy and a company governance compromise in order to make coherent product policy, productive organization and employment relationships, along with the relevance with respect to the macroeconomic growth mode’ (Boyer and Freyssenet, 2002). They are rather stable but not fully closed production systems as specific answers to common issues of firms in a specific industry. Major questions of productive models concern the product markets and labor (Bélis-Bergouignan et al., 2010) and the coherence of answers is embedded in the compromises established between stakeholders. The authors articulated the concept with their deep understanding of the functioning of Western capitalist economies of the after-war growth period. The links between the macroeconomic environment together with fundamental dynamics of aggregate demand and productive models developed by economic actors provide a solidly built macro-level base which does not exist in the business models literature where the point of interest is mainly the specific demand for the specific commodity to be produced by the specific firm or network in question. The role of institutions in shaping productive models by creating constraints or enablers is critical (Lung, 2008). Positioning itself against the mainstream analytical perspectives which put markets at the center of the analysis as the conventional space of coordination between economic agents, regulation theory puts institutions as one of the bases of economic activity in the sense that these institutions like monetary regimes, forms of competition and employment relations shape the conditions of growth regimes. In this respect, market, as a social construct, is another institution which maintains the agreements on quality, the organization of exchange, the conditions of access to market and the regulation of transactions (Boyer, 2004). In addition, productive models' emphasis on the compromise between different stakeholders as a determining component of profit strategy of firms which also give shape to their productive organization is fundamental.

Within this perspective, an appropriate profit strategy is central to the applicability of certain models. The strategy should count in existing market and labor characteristics and the uncertainties attached them. It should be feasible and exploitable and in order to do so, it should admit the existing growth mode of the economy in which the businesses activities reside. The variety of growth modes are institutionally characterized and historically shaped (Boyer and Freyssenet, 2002). Competitive advantages that an economy possesses in terms of the strength of key actors like firms, labor force, infrastructure or financial stability, provide the necessary conditions or frameworks for generating specific profit strategies.

On top of this macroeconomic context which conditions business firms' 'socio-productive configurations', the authors present a three-pillar framework composed of product policy, productive organization and employment relationship, as components of productive models to implement the profit strategies that the firms desire to follow. Even though these aspects are strictly relevant to the general framework provided by the regulation theory, neither the details within existing elements nor the reasons why other factors that still have an impact on profit strategies are not deeply articulated beyond its application on automobile industries of the developed economies. Moreover, different than their early conceptualization of 'industrial models' (Boyer & Freyssenet, 1995) which give a more egalitarian structure between the components of the model, the productive models approach rather represents a hierarchy among its components that the product policy which refers to the decisions over the choices over design, volume, quality, novelty, the only component with a 'policy' denomination, designates the choices over the productive organization referring to the methods and means chosen to enable product policy and the employment relations referring the system of recruitment, remuneration, promotion, as well as representation of the workforce (Boyer & Freyssenet, 2000a). The aim is to establish necessary complementarities between these components in the form of a governance compromise among all the stakeholders involved. The formulation and application of this compromise is the fundamental aspect of a working model (Lung, 2005). The opposite forces of compromises; conflicts or their management, are not integrated within the model framework. They can only threaten established models.

1.10 Main issues of models

1.10.1 What is different with strategy?

One important point is the difference between business strategy and business/productive models. Even though the two terms are still used interchangeably, the efforts to distinguish them or the integration of business strategy in different forms within business models would be necessary to clarify certain aspects.

In the business model literature, there is yet no agreement on the content of business strategy which help scholars to define their own business model frameworks. It is the analytical focus which mainly shapes the form of strategy and the focus is formed where the determinant action occurs. Depending on the point of interest, the action can be formulated around the relations between organizations within a value chain or network; the relations within organizations to create value; or value propositions to customers and the business model related to it.

However, there are still efforts to distinguish the two. Magretta (2002) proposes business models as static patterns on which firms build their rather dynamic strategies to apply the model in order to sustain their competitive advantage or 'to deal with the reality'. Similarly, Teece (2010) highlights the generic character of business models compared to business strategies that the design of a successful business model should be complemented with a mindful competitive strategy in order to benefit from the innovation performed by the firm. However, there is no complete matching between a model and a strategy. While firms are following similar strategies in identical product markets, they may also have different business models. In this context, business models and strategies are complements (Zott et al., 2011).

In the productive models perspective provided by regulation theorists, strategy has a central role in the functioning of the model followed. As it is explained above, productive models are built to implement profit strategies of individual firms. These strategies are not only limited to product policy but they cover a wide range of choices and preferences selected upon different aspects of productive activity either internal or external to the firm. The activities and topics covered under the components of models to be implemented through strategies are not very different than the business literature on strategy even though the construction of the links between these components and their relevance to the general macroeconomic structure structurally differ in productive models approach. In the face of extensive uncertainty, by mobilizing their resources firms seek for a certain designation which associate the external relevance within the given socio-economic context and the internal coherence between the varying organizational dimensions of the firm (Lung, 2005). For the automotive sector, these strategies may concern issues as broad as innovation, flexibility of production, productivity increases (permanent reduction of costs, production scale (volume) or product range (diversity) which have fundamental organizational, financial and employment implications like any corporate strategy over the course of productive activity may have.

1.10.2 A different model for each firm? – The variety in models

The second major issue with proposing models as analytical frameworks to study business organizations is to deal with the question over potential diversity of singular models within different contexts and time periods. The question if there exists a single model valid for a specific context or there is a potential to exist several models still valid for the same context is part of a major issue in economics and business and one of the main sources of the basic division between mainstream and heterodox perspectives in economics. Both the modelling of the optimizing firm of neoclassical economics and the mainstream 'one best way' business propositions reject the idea that the heterogeneity of firms is not theoretically valid as the best performing model sooner or later dominates the market of its main activity. However, the research repeatedly confirms the diversity of models even among best performing firms of similar contexts (Boyer and Freyssenet, 1995; Lung, 2005).

The diversity of organizational forms and performance which are conditioned due to institutional differences emerging from distinct socio-economic paradigms of primarily national contexts is a broad discussion in the literature (Chandler, 1990; Hall and Soskice, 2001; Jessop, 2011; Lazonick, 1990a; Whitley; 1999). Diversity is also an integral part of the Regulation theory and its analysis over models of productive activity as the theory considers socio-economic conditions is the determining force for the growth modes of firms and their profit strategies in specific geographies (Boyer, 2004; Boyer and Freyssenet, 2002). Accordingly, variety in growth modes between nations, in profit strategies and in governance compromises between firms provide the unsurprising diversity in productive models (Freyssenet, 2003). Moreover, continuous restructurings of industries through the introduction of new technologies which create new subsectors and segments as well as the corporate rearrangements through unceasing mergers, acquisitions and alliances provide relevant inputs to consider the continuous metamorphosis of models of every type.

The second point which gives support to the view that there is a diversity of models is the existence of firm-specific differences that are independent of the institutional contexts they act. These differences emerge from the different strategic orientations which guide decision making, different organizational structures of utilizing capabilities that result in distinctions in abilities to generate and gain from innovation (Nelson, 1991). More detailed observations of the qualitative features of firms including new entrants to an industry is a necessary condition to expose the variety along new model propositions which are always possible (Nelson, 2008). From a different interpretation which gives the same sense, the great variety in the ability to act on same institutional structures for company managers also implies the diversity in productive models (Boyer and Freyssenet, 2002).

Lastly, the singularity of the models in the business model literature deductively assumes a great diversity of potential models as the source of competitive advantage (Zott et al., 2011). It is the general aim of firms to build distinct business models hard to be copied by others to create and appropriate value from its activities (Chesbrough, 2010; Teece, 2010b).

1.10.3 The role of technology in model formation

The relation of business/productive models to technological change and innovation is another important dimension in models research. Some scholars put technological development in the center of the models analysis that, being the structure that plays a mediator's role in the value creation process, a business model helps the firm to select and reconfigure technologies in transforming them into end products with commercial success (Chesbrough and Rosenbloom, 2002; Teece, 2010b). The role of a business model in the association of technology development and value creation is so strong that despite advanced perception of specific technologies, any potential conflict between the existing business model, and any potential one required to exploit the emerging or disruptive technology would hinder firms to translate innovative strength into commercial success (Christensen, 1997; Teece, 2010b). Thus the business model, within this perspective, has a bridge role between a firm's innovative capabilities to the other capabilities needed for competitive advantage (Zott et al., 2011).

The link between technological advance through innovative capabilities and organizational configuration is also highlighted by economists. Differences between firms in how they organize innovative activities and how they gain from innovations result in myriad of differences among firm performances (Nelson, 1991). The endogenous character of technology and technological change in economic activity is also critical in regulationist perspective. The coherence between technology, organization of work and institutional patterns gives shape to a growth regime which conditions firm strategies (Amable, 2002). Technological progress emanates from the unending search for new sources of profits through new products, processes and markets which can only be implemented through coherent productive models (Boyer and Freyssenet, 2002). Resulting technological advancement further extends the market place and the division of labor. Innovations can only be considered successful through their market potential and organizational capability to react to this potential (Boyer and Freyssenet, 1995, 2000b) thus they cannot be considered independent of any propositions by firms in the form of productive models.

1.10.4 Are business models subject to change?

During major ideological transitions like the one from managerial capitalism to shareholder capitalism which accompanied reconsideration of value appropriation/extraction structured with changing power relations, business model frameworks are also subject to change. In need of new value propositions through flexible structures in every aspects of productive organization (workforce and shop floor organization, R&D partnerships, outsourcing, etc.) in order to create more value and capture/extract more of it from others, to contrive moments of maximum leverage over stakeholders (workers, contractors/suppliers, state), it may be necessary to free productive activities/resources and strategic control from the hands of rigid structures of existing forms of management.

On this issue Lazonick (2009) proposes a relevant distinction between an old and a new economy business model in a way that the modes of organizing business firms has dramatically changed not only the resource allocation for productive uses, but also the ways and terms of employment. Primarily dominating the US economy associated with volatile stock markets, unequal incomes, and unstable employment, it also has a great impact on the ways of doing business in around the world. The conflicting and contrasting elements of the strategic, organizational and financial categories of these two models underlie a rupture between the older and newer forms of productive activity. In the case of strategy for example, a prime shift is observed from vertical integration of production or big corporate R&D labs to vertical specialization and increasing outsourcing (Lazonick, 2010b).

The power of change is also relevant for both business model and productive model perspectives. For some business scholars, business models are concepts to be innovated in order to renew growth prospects and competitiveness (Chesbrough, 2007, 2010; Mitchell and Coles, 2003). From the productive models perspective, even though a specific model is an outcome of a process during which some degree of coherency is established between the product policy, the productive organization, employment relationship, and the profit strategy that is being pursued, because all the process is unintended and unable to be designed in advance, change is inherent in all models (Boyer and Freyssenet, 2002). Even though it is not so easy to shift between two models, if an existing model, faced with constraints or changing objectives, starts to use new organizational, technical, managerial and social measures with 'superior' results compared to the previous situation, it can be considered as a new one. There is an internal dynamic of the contradictions and possibilities that render models mortal (Boyer and Freyssenet, 1995).

1.10.5 The usefulness of models in economic research

The lack of a business/productive models perspective in economic theory (Teece, 2010b) is a major handicap of any micro-level economic analysis trying to uncover the transformational dynamics of productive activity. Efforts of the proponents of regulation school to explore the dynamics of automobile industry in the 1990s through the productive models framework have to be enlarged and renewed with an updated view of 21st century capitalism. Such an updated framework has to be built around an alternative theory of the firm, once again, against mainstream perspectives and their hypothetical firm formulation.

Ahistorical perspectives especially in the case of business models literature and resource based views make it difficult to understand the dynamics of change at different levels of economic activity and the role of innovation. The latter should be understood as a cumulative and collective process crucial for sustainable competitive advantage for companies and sustainable prosperity for economies which entail robust value chains, continuous skills development efforts of businesses and governments, healthy financial infrastructure supporting productive activity and egalitarian distribution of created value among stakeholders.

One critical factor in shaping these models, the role of finance in redefining productive strategies and organization is largely missing in most part of the existing literature on business/productive models. Though it was present in their early work as an equally important element of industrial models as expressed in the relation between productive investment and access to finance including the capacity to self-finance (Boyer and Freyssenet, 1995), the productive model theorists, in their later conceptualization, the impact of financial constraints and/or motives on productive model building largely disappears even though finance as an institutional determinant is still available in their macro level analysis on social systems of innovation (Amable et al., 1997 in Lung, 2005). Their analysis is truly aware of the fact that financial sphere would have important consequences on governance compromises. On the other hand, productive models consider firms in a way that firms either have full control over their financial resources or the impact of finance in rebuilding the governance compromise may only appear when companies lose their control over their shareholders and finance mechanisms (Boyer and Freyssenet, 2002). The role of finance within the dynamics of business organizations in distributing the value among stakeholders who created it through their collective and cumulative efforts is not highlighted. In effect, the financial mechanisms of value creation and value extraction are fundamental in reshaping this governance compromise acceptable for the actors/stakeholders involved.

In a different vein, without any political economic perspective, business scholars studying business models as value creating mechanisms skip the value extraction and value sharing among stakeholders as a whole. Value is only 'captured' from internal and external innovative activities through a working business model without any socioeconomic mechanism explained (Chesbrough, 2010; Teece, 2010b). Very few attempts show that the efforts to empirically estimate the sharing of created value among stakeholders are very limited (Garcia-Castro et.al, 2013; Lieberman and Balasubramanian, 2007).

On the role of finance in building business models, one exception provides important insights to the financial sphere of business/productive model discussion. Haslam et al. (2012) provides a perspective in that the purpose of establishing a business model is to generate financial surplus through leveraging stakeholders. From a different perspective, they provide some insight on the purpose of a business model still connected to the basic definition of business models within business literature. Rather than the emphasis on the role of business models as a construct that mediates the value creation process, they highlight the leveraging and manipulating role of corporate finance and it is the business model which generates the financial surplus out of the interactions between stakeholders involved. In that sense, their approach resonates to the one provided by the productive models framework in which a governance compromise between different actors of the productive activity including workers, managers, suppliers and shareholders (Boyer and Freyssenet, 2000a). Through a process of *arbitrage*, interactions between these stakeholders is used to extract financial leverage and it is the model which gives a certain coordination to these interactions (Haslam et al., 2012). However, their analysis still lacks an explanation over the representations of value extraction from the view of the leverage applied by certain stakeholder alliances over others and survival strategies of oppressed stakeholders. Nevertheless, they rightfully express the function of business models as the coordination of complex stakeholder interactions in order to facilitate rather indifferent utilization of resources and capabilities for value capture, as well as the translation of these interactions into financial leverage. In that sense, there is no compromise but a continuous clash between stakeholders expressed in financial transactions and representations.

Accordingly, employment relations should also be a major element of models discussion. The dynamics of employment or *rapport salarial* has long been a key element of analysis of Regulation theory and a major component of productive models framework (Boyer, 2002; Boyer and Freyssenet, 2000a; du Tertre, 2013; Grahl and Teague, 2000). *Rapport salarial* can only be defined by the interaction between the institutional framework around labor in general (legal and regulatory conditions) and social relations of work (Boyer, 2002; duTertre, 2013). To regulationists, the social compromise established between workers and management is the fundamental motive over the course of economic development documented through the post-war upswing of Western capitalism. Like in the monetary regime and forms of competition, the two other institutional forms defined by the theory, *rapport salarial* is principally applied through macroeconomic analysis of economic activity. The diversity of labor at firm and industry level shaped by different forms product markets, intensity of technical change and the organization of work makes it a delicate work to propose definite categories of employment relations (Boyer, 2002).

Indeed, employment relations or *rapport salarial* in its macro context should be rearticulated in model-type analyses of firms and industries of the 21st century in order to reestablish the interplays between value creation through the productive activity of workers and the outlook of its remuneration in a secure and equitable way. In order to do so, the analysis over employment relations should include not only the role of institutional framework. It should also assess the means by which the management deals with the workforce in the face of competitive pressures or distributional motives shaped with the help of discursive elements like core competencies, shareholder value or corporate social responsibility.

Diversity of models across time and space is expressed by the whole business/productive models literature citing a wide range of organizational and institutional factors. In effect the diversity is the rule rather than exception even among firms within the same industry in the same geography during the same time period. Especially in the business models literature, models, where the sources of competitive advantage reside, are usually unique to firms while a successful one is always open to imitation by others (Teece, 2010b).

However, none of the existing perspectives discuss the possibility of a dominant paradigm across industries penetrating into different geographies with differentiating features in industries and economies in order to give model framework a potential to be a strong analytical tool. The discussion of the regulation theory over the dominant development model labelled 'Fordism' was pursued at the firm level through the application of productive models framework where Fordist model is reduced to one specific productive model in automobile industry among other models. The alternative explanations to distinguish models of firms of different geographies including Japanese model vs. American Model (Aoki, 2001), Varieties of Capitalism (Hall and Soskice, 2001), Diversity of Capitalism (Amable, 2003) and others (Jessop, 2011; Lung, 2005) have been mainly focused on institutional factors and their relation to market forces. The research on organizational dynamics has not led to a general framework for the capitalistic change of the productive activity. As a result, the construction of new business/productive models and the relations and hierarchies among them due to distinct organizational and institutional factors are not well formulated within a historical context, different than the previous scholars like Marshall, Penrose or Chandler who embraced a historical perspective and analyzed features of business activity and firm organization. Perspectives formulated around world level phenomena like neoliberalism, globalization or financialization, have not so far led to shared frameworks among social scientists to analyze micro dynamics within, for example, business enterprise.

1.11 Model proposition of this study

As a result, an integrated methodological perspective is needed which discusses specific forms of business/productive models of the 21st century including the ones in commercial aircraft manufacturing. The divergence of scholarly concerns and analytical perspectives within this 'models' literature hinder the potential to offer a methodological set to be applicable to different industries and firms. As previously stated, the empirical investigation of productive models' was only on twentieth century auto industry and the atomized approaches to business models do not help to constitute a solid template to analyze a specific case within a broader model framework. As it is highlighted, a theoretical background is critically needed to put forward the fundamental elements of proposed models and to exert analytical rigor on an empirical study.

The proposition of this study is to analyze a superposition of certain generic activities to be detailed below during a specific period in a specific industry which becomes the dominant pattern for business activity at the global level. The pattern contains specific features dominant in certain aspects of productive activity like in product designs and related technological understandings, marketing strategies, value chains, relations with institutions among others. Its basic function is to deal with *value creation* and *value extraction*.

Highly relevant to a models discussion for the research on certain industries and firms, Lazonick (2013) provides a comprehensive view of business enterprise which is involved in three generic activities to transform productive resources into commodities to be sold. These activities are;

> *"Strategy allocates resources to investments in developing human and physical capabilities that, it is hoped, will enable the firm to compete for chosen product markets. Organization transforms technologies and accesses markets, and thereby develops and utilizes the value-creating capabilities of these resources to generate products that buyers want at prices that they are willing to pay. Finance sustains the process of developing technologies and accessing markets from the time at which investments in productive resources are made to the time at which financial returns are generated through the sale of products"*.

This study assumes that a business firm's execution of each of these activities, or their *modes of action* in the regulationist sense, identify the guidelines of its business or productive model. To specify the framework of the analysis, within a specific industry for a certain period of time, there may be a dominant model adopted by prominent firms of the industry. However, certain aspects of the model may or may not exist in one firm or in another depending on their different orientations structured by their historically shaped organizational characteristics. In that sense, the proposition respects Boyer and Freyssenet's (2000a) reminder that the context of the identification of a model as a response to new questions of economic profitability and social acceptability which are inherent in previous models' dynamics as well as in the transformations of competitive, macroeconomic and societal contexts either at national or global levels. Equally important, the institutional environment may or may not allow firms to put forward certain aspects of the dominant model, compel them to modify it or apply its constituents differently. Despite a growing interest within the business literature, there is still a requisite to explain business/productive models within the domain of economic theory with an emphasis on technological change, industrial relations, financial orientations, and regulatory frameworks. Each of these concepts is a major determinant of the particularities and boundaries of a model at a specific point in time, within defined geographies and industries (Montalban and Sakinc, 2013).

Thus, for the purpose of this study, systems integration is proposed as a new business/productive model for commercial aircraft manufacturing that implies, in summary, a Chandlerian type organizational learning strategy in a regulationist macro environment highlighted with the orientation towards shareholder value in the last several decades. Within the framework of a model, business enterprises follow their basic aim of generating a surplus and reinvest or redistribute it to certain stakeholders while coping with different types of uncertainties and adapting to changes along new product development like new shop floor practices, new technologies, new communication forms and channels, and new product market environment, among others.

Similar to the relation of organizational capabilities for the managerial capitalism of the twentieth century depicted by Chandler (1992), the new face of systems integration as a core capability of the modern corporation (Hobday et al., 2005) can only be understood if we establish the relation between the development of such new capabilities and the remaking of business enterprise. It is the centrality of the relation between the organization of production[1] and business strategy in systems integration (or in any other business orientation) that provides a research framework to analyze the meaning of systems integration for the commercial aircraft manufacturing primarily represented by Airbus and Boeing[2]. Furthermore, in order to develop necessary productive and organizational resources and fund new product development, business enterprises together with their stakeholders are also required to provide financial commitment. As a third element, finance and its impact on strategic decision making and organizational integration should also be analyzed. This aspect, which has been restricted either to the research on financial performance or policy discussions, has been largely ignored by organization and technology scholars for a long time.

[1] Organization of production should not be confused with productive organization of the productive models approach which largely refers to the strategy component of the systems integration business model detailed below.

[2] Commercial aircrafts or commercial jets are airliners with more than 100 seats. As of early 2016, only Airbus and Boeing are producing commercial jets of this type. In 2016, Bombardier will start to deliver its first commercial aircraft in smallest segments to become the third company of the industry after 19 years of a duopoly of Airbus and Boeing since the acquisition of McDonnell Douglas in 1997 by Boeing.

However, the commitment and the control over financial resources and the pursuit of financial objectives are vitally decisive over the integration of business strategy and organization of production.

Therefore, a study on the implications of the systems integration approach in the commercial aircraft industry should first deconstruct the discourse of systems integration particularly embraced by Boeing and to a lesser extent by Airbus[3]. Such an analysis should include the research on underlying motives and potential outcomes of their actions while they reorganize their productive organizations within and outside of their boundaries. At the end, systems integration can be understood as a business/productive model which can be explained through reformulated structures progressively embedded in their business strategy, productive organization and corporate finance.

In effect, the interrelationship between business strategy and workplace organization/work system and corporate finance is a matter of debate. Several studies have so far tried to approach this relationship through one or two dimensional perspectives exploring the impact of one aspect on another. The aim of this study is to make a contribution to this debate through an empirical exploration of these issues in commercial aircraft manufacturing. In this case business strategies should be understood as firm location in product markets, firm location in capital markets (Froud et al., 2006) and also firm location in labor markets or more accurately labor dynamics. Due to the firm connections among these three dimensions and their dynamic nature, they are interdependent rather than one is dependent on the other.

1.12 The concept of systems integration

To define the topics of discussion of the second part of this study around the systems integration model, first it is necessary to describe the course of development of the concept in its historical context in order to prevent any misunderstanding around its designation.

1.12.1 Conceptualization of the term

The concept of systems integration is originally derived from systems engineering; the work of organizing and bringing together different processes of the development and production of

[3] In the case of Airbus, the new orientation has been defined more technically as New Systems Policy which is detailed in Chapter Three.

complex new products i.e. systems (Johnson, 1997). The notion of 'systems' has a widespread utilization in theory and practice. Conceptualized as an engineering element of production process, systems integration was developed from 1940s to 1960s as a means to coordinate and control the development of complex aerospace and computing systems particularly utilized by the US government. Principally, systems engineering was the latest stage of systems/product development, the final integration of the components built by different organizations involved in a project. It also included testing and verification of the final product after all the components are integrated (Johnson, 2003).

In the wake of systems engineering, systems integration emerged as the task to bring together different components of a weapon system which were previously performed within the walls of government owned and managed arsenals. Later, these tasks were progressively assigned to business firms, to let them develop weaponry and aircraft systems (Sapolsky, 2003). Consequently, the reliance of armed services on business contractors increased after the WWII. Rather different than the war time when the race was on weapon mass production, the military-technology race of the Cold War focused on new weaponry development in which technological performance mattered more than quantity of output produced (Jones, 1990; cited in Sapolsky, 2003). However, the rapid change of technologies and processes of systems made their development, integration and utilization major challenges to overcome. In order to reap the benefits of rapid progress in technologies, coordination had to be well established and continuous learning and the development of new skills became central to the work of system integrators. As a result, systems thinking started to define the standard method of organizing R&D in the aerospace industry. Subsequently its utilization expanded to other industries in and outside of the United States (Johnson, 1997).

Specifically, in aerospace industry systems integration emerged as a standalone assignment to bring together different systems like electronics or weaponry that had to be designed along with the aircraft from the very beginning (Johnson, 2003). The prime contractor, main integrator of the final product as a complex system, had to develop the systems knowledge necessary to understand and coordinate diverse talents and technologies required to develop final systems by attracting and mobilizing skilled scientists and engineers (Sapolsky, 2003). This knowledge has always been the main tool that has to be heavily invested by firms in order to cope with technological uncertainties which pervade the design and development of a new airframe or a new engine (Mowery and Rosenberg, 1989).

Thus the main function of systems integration is the ability to maintain necessary communication and coordination of a predominantly multi-actor project from the preliminary design till customer services confronted with a tremendous level of uncertainty due to the magnitude, novelty and complexity. It is primarily a social process which necessitates behavioral and cognitive solutions provided only by appropriate organizations which aim to improve and manage the communication and control of technical development.

1.12.2 Capability-Based Discussion

The implementation and the management of systems integration by business enterprise rather than the government and its transformation from a communications method to a source of competitive advantage require discussion on what social scientists and business scholars say on systems integration as a business strategy. In the last decade, a limited but focused body of research has been performed by a group of scholars embracing evolutionary and resource-based views on the coordination of technological capabilities and knowledge within and across the boundaries of firm (Acha et al., 2007; Brusoni et al., 2001; Brusoni and Prencipe, 2001; Hobday et al., 2005; Prencipe, 2001; Prencipe et al., 2003; see EMR Special Issue, 2009). The research is limited due to the nature of systems integration as a tool specific to multi-actor and multi-tech sectors. However, the rising importance of such sectors like telecommunications, electronics and aerospace and increasing relevance of the concept to the innovation strategy and knowledge management of corporations active in these sectors have made existing and further research valuable.

The literature discusses systems integration mainly as an issue of capability management along changing firm boundaries. This change can either be through backwards disintegration as a result of increasing outsourcing including design and development of components or final products (Pavitt, 2003; Sturgeon, 2002) or forward integration into services and business solutions for existing or novel products by moving downstream into the provision of services to distribute, operate, maintain and finance a product through its life cycle (Davies, 2003; Wise and Baumgartner, 1999). In both cases, systems-integrator companies develop and utilize different problem-solving capabilities to deal with necessary integration of distinct systems while they function in harmony when they are brought together. Adopting systems integration capabilities is understood as a competitive process of coordinating tasks for different sections of systems, integrating them and maintaining the continuity of the final product by supporting and offering necessary services and solutions. One basic question is how firms organize themselves to manage technological evolutions around complex products. Rising complexity, rapid technological change and the extension of knowledge paths to develop new systems force firms to adapt new forms of design, development and manufacturing in order to preserve their competitive advantage. Thus systems integration is embedded in the business strategy of a firm to manage value creation both internally and externally.

In that regard, scholars of industrial organization and innovation have addressed the role of systems integration as a new stage in the life of the Chandlerian enterprise (Hobday et al., 2005; Prencipe, et al., 2003). Basically driven by better understanding of technologies, and accumulated and codified knowledge, firms are enabled to hive off some of their in-house activities or to skip the option to develop new resources and capabilities necessary to design and develop parts of a technologically complex new product while keeping the coordination and final integration under control which may or may not include vertical integration through different phases of the new product life cycle (Brusoni and Prencipe, 2001; Hobday et al., 2005). At the end, armed with systems-integration capabilities, firms are able to choose whether or not to outsource specific elements of design and production (Prencipe, et al., 2003) and they basically 'know more than they do' thanks to these capabilities needed to actively manage technological and organizational interfaces (Brusoni and Prencipe, 2001). The feature that accompanies the technological aspect of systems integration is the organizational dimension which expresses the involvement of different organizational profiles like prime contractors and subcontractors as well as technical advisors and government bodies in a systems integration task (Gholz, 2003). These profiles bring their specific technical and management skills for the execution of integration. In this context, outsourcing is an integral feature of systems integration that the firms outsourcing parts of production have to possess necessary organizational capabilities to integrate components produced or knowledge generated by suppliers (Pavitt, 2003).

Thus, systems integrators are the key actors of innovation by maintaining a diverse set of competences across a wide range of technologies and scientific disciplines (Acha et al., 2007).

Several studies have already documented the competence development through increased technology diversification provided by the increase in the diversity of patents filed by firms in high-tech industries in the last three decades (Acha and Brusoni, 2008; Brusoni and Prencipe, 2001; Brusoni et al., 2001; Dibiaggio and Nasiriyar, 2009; Granstrand et al., 1997). These perspectives provided a variety of explanations for organizational solutions of firms faced with intense competition and rising demand for more complex and better quality designs. At the end, as an outcome of increasing specialization in knowledge production (Pavitt, 2003), systems integration is principally a capability either limited to coordinate the diverse and complex learning trajectories of suppliers and to orchestrate their network (Brusoni and Prencipe, 2001; Dosi, et al., 2003) or expanded to redesign of an existing system in order to take full advantage of a technical innovation which may involve not only product design but also the plant layout, production system, and business organization (Best, 2003).

Systems engineering and systems integration are not new concepts in aerospace. In different ways they are expressed in terms of technical and organizational capabilities of corporations inclined to organize and run the design, development and operation of technologically complex, innovative, learning stage (in the sense that knowledge accumulated to develop and operate the final product and its components is new) and high cost programs performed by multiple actors. If systems integration is the organizing of innovation and production processes, the analysis should establish the links between new product development efforts of a productive organization and the broader business/productive model of the same industry.

The development of capabilities and their utilization is the essence of a broader business strategy of acquiring competitive advantage. If these scholars correctly define systems integration as a capability, and highlight its importance for innovative performance, they fail to connect this capability development process to broader strategic, organizational and financial challenges that these corporations have to meet in order to sustain their innovativeness and transform it into prosperity for their stakeholders as the basic aim of business enterprises. In order to identify underlying reasons for shifting boundaries of firms or the passage from vertical to systems integration, a reformulation is needed which provides a broader framework unrestricted to the imperatives of technological transformations and resulting organizational changes. Any analysis which purports to reveal the underlying mechanisms of the organization of innovation should consider the deliberate action of business firms to organize capability development of their own and their partners in a systematic way that acknowledges not only the technological requirements and future resource needs but also the shape of commercial, organizational, financial and even political conditions that usually cannot be measured quantitatively or technically. For example, inter-firm relations can be considered as combinations of these internally produced and externally gained capabilities along new product development efforts. Systems integration as the outcome of these combinations is itself a new form of competence in the value-creation process and it has its own dynamics in control, organization and finance of a firm.

The integration of capabilities into the production process is not automatic. The interactive social, hierarchical and power relations-related characteristics of the integration have to be highlighted as well. In essence innovation research has to have a human face. Not only engineering but also a social one.

1.13 Why systems integration can be a business/productive model?

First of all, in order to propose systems integration orientation of commercial aircraft manufacturers as a business/productive model, the role of organizational capabilities in shaping such models should be reformulated in a way that they are developed and deployed through the strategy, organization and finance superposition proposed as the main analytical tool of identifying specific business/productive models.

Thus the research framework in the form of models discussion should be able to provide explanations to the questions from the more general to the more specific including:

- What role do capabilities play in defining the R&D and manufacturing processes of firms?
- What are the means of capability development efforts of business firms?
- How do firms construct and coordinate complex systems of innovation, what are the implications of finance/governance/employment and what are their implications on innovation?
- How do firms take their decisions to launch a new product development program?

- How do they define product & process strategies of the new product (the dynamic processes of integration, disintegration, externalization, internalization, upgrading, downgrading)?
- How do they shape and reshape their value networks/chains?
- How do they define in-house organization of production and the incentives for its continuity? How do shop-floor dynamics intervene?
- How do they finance new product development and how do they distribute the benefits of innovation among different stakeholders?

Around these generic questions, the second part of this study discusses the model around the three elements below. The theoretical, conceptual and historical discussions of the issues raised within the frame of each element are performed in earlier sections of each chapter before the empirical analyses are proceeded, and convergent and divergent practices of the two firms are explored with respect to the dominant systems integration perspective.

1- Strategy: Detailed in Chapter Three, strategy is primarily about the planning and management of the new product development process as an innovative activity. In this sense, it largely overlaps with the 'productive organization' component of productive models framework which refers to the methods and means to pursue a specific product policy. It deals with the decision-making functions of corporate executives and their implementation through the planning and execution of the resource-allocation process among different parties to develop required capabilities for innovation. The decision-making capacity of these actors includes but is not limited to the definition of the product policy in general; the reorganization of supply chains and collaborations; and the efforts to enhance internal R&D and other types of investments for new product development. Their ability to maintain a certain balance between internal and external allocation of resources, the positive impact of their decisions over a wide range of stakeholders involved in the productive organization, and the alignment of their interests with all these other productive actors unquestionably act on the competitive advantage of their business organizations and the prosperity of the societies they serve.
2- Organization: Detailed in Chapter Four, organization represents the action of the workforce in transforming knowledge and technologies to generate products to be sold in the market. The basis of this action is the development of organizational and value-

creating capabilities within a robustly functioning productive setting providing the means and incentives to these actors to apply their skills and efforts in line with strategic objectives. The setting deals with modes of compensation in the forms of work satisfaction, promotion, remuneration, and benefits as important instruments for organizational integration that should motivate employees as individuals to engage in collective learning (Lazonick, 2013). It decides on the ways in which a firm recruit, retain, motivate and reward its employees and how does the structure of incentives align individual behavior with organizational goals. Together with the compensation system, the collective representation and potential mechanisms to include workforce into decision making are essential for the realization of these goals. The power of the workforce representation and employee voice to have an impact over organizational issues like skills formation, flexibility of work, job security, besides remuneration and benefits are the major themes to analyze in order to reveal the organizational dynamics on the shop floor and their implications over the further strategic moves of business firms.

3- Finance: Detailed in Chapter Five, finance is about the commitment to provide necessary funds for the process of developing products and accessing markets and the distribution of returns among stakeholders that are generated through the sale of products. One important point to highlight is the different means of finance depending on the facility of their access and their collective character due to a broad group of funders involved from investors to banks and sometimes, even more importantly, governments as discussed in Chapter Two. Beside the commitment of these actors, the degree of their power to extract the value created beyond or behind their contribution to the innovation process and productive activity is also decisive over the continuity of innovation in the long-run. How these actors build up their identity and how they impose it over corporate governance in order to consolidate their power over the control of value extraction are extremely relevant questions for the discussion of the concepts of maximization of shareholder value in modern capitalism and its impacts on productive capabilities.

One last but highly relevant concern before concluding the chapter is to include the institutional impacts over corporate actions through each of these three elements of business/productive models. Mainly because this study considers institutional elements as important explanatory factors as organizational ones, the role of government actions, legal rules or national, macro-level factors in general are highlighted whenever relevant but they don't constitute the point of departure for an analysis of organizational dynamics of business firms as they are specified as the unit of analysis in the analytical methodology. One exception as it is deeply discussed in Chapter Two is the role of governments in funding the process of product development in commercial aircraft manufacturing as an indispensable source behind the success of Western manufacturing in aerospace. Nevertheless, even to compare institutional differences, a firm-level analysis should be the principal starting point to reveal the real differentials. The disequilibrium and conflicts at organizational levels call for a redefinition of the rules of the game (from firms to institutions) but they are usually left unanalyzed or unspecified as main analytical points.

Thus, this study adopts a dynamic perspective that both organizations and institutions evolve together and one's mutations, adaptations, inclinations characterize those of the other. The organizational setting within a business enterprise is always subject to evolve as their strategies and the speed and direction of change of organizations (enterprises) and institutions are not always congruent. Skeptical of the one-way determinism of Variety of Capitalism approach on the power of institutions over organizational boundaries by overlooking the dynamics of organizational strategy that may modify the nature of these institutions, Sako (2006) argues that while institutional constraints and opportunities shape the strategies in ways that differ across national business systems, strategic interactions may bring forth changing institutional structures. Similarly, Lazonick (2011) highlights the potential power of business enterprises to engage in collective action to reshape institutions in line with their strategic, organizational, and financial needs. Even though the national institutional arrangements, through differently organized and regulated firms and markets have certain power to impose on, business firms are still dynamic actors to come up with unexpected results beyond the reproduction of national systems (Lippert et al., 2014).

As a result, in considering the role of institutions in a comparative-historical research, one should be careful not to fall into the trap of simplistic categorizations of Variety of Capitalism approaches or the dead-end of Regulation school's empirical research on firms and industries because it leaves no space to focus on key determinants of success other than institutional factors. This study, on the other hand, rejects institution-determinist perspectives and takes business enterprise as the starting point and the main unit of analysis. It basically compares a business firm which institutionally belongs to a single nation-state with another one which spread across four different countries in Europe having unique aspects in terms of corporate governance and related compromises.

1.14 Conclusion of the chapter

This chapter lays out a framework describing the elements of analysis of business firms from a comparative-historical perspective. The point of departure of the analysis is innovation as the engine of growth and productive capabilities as firm-specific enablers of innovation. In order to establish the link between innovation and productive organization, business firms have to develop capabilities specific to their industrial use in their efforts to create value.

In this context, a model perspective is proposed to investigate the generic activities of business firms as an analytical tool and a research framework. To do so, a highly eclectic business literature on business models and institution based productive models perspective of Regulation school are described to explore the potential of a model methodology to identify the dynamics of productive activities of business firms and their orientation. Different aspects of models in terms of their relation to business strategy and technology, their variety with its reasoning, their dynamics of change and their usefulness as methodological tools are elaborated by referring to the correspondent discussion within business models, productive models and other relevant literature.

To be detailed in the earlier sections of the chapters of the second part, the main proposition of this study is to analyze a superposition of strategy, organization and finance as the generic activities performed within a business/productive model framework shaped around shared or exclusive aspects depending on convergent and divergent practices around a dominant perspective followed by the main actors of a specific industry.

Following, the chapter discusses the dominant pattern of business activity and productive organization in commercial aircraft manufacturing labelled as the systems-integration model. Before that, the concept of systems integration is elaborated first as an as an assignment and a pool of knowledge to coordinate diverse talents and technologies required to develop final systems, and then as a core capability to understand and to manage the growing complexity of innovation processes. Following, the deficiencies of these the resource and technology-based approaches due to their lack of a perspective connecting the capability development processes through systems integration to broader strategic, organizational and financial inclinations of the very same business organizations are highlighted.

Finally, for the purpose of this study, systems integration is proposed as a new business/productive model for commercial aircraft manufacturing having distinct strategic, organizational and financial particularities stressed at different levels by firms depending on power dynamics, institutional restrictions or historical evolution of their productive organizations.

Chapter Two

Industrial Dynamics of Aerospace and Commercial Aircraft Manufacturing

2.1 Introduction

The aerospace industry is a high-technology manufacturing sector that produces aircraft, guided missiles, space vehicles, aircraft engines, propulsion units, and related parts. Besides manufacturing it also offers services related to product supply like aircraft conversion, and maintenance, repair and overhaul services for the entire product lines. The industry is dominated by a limited number of large firms whose customers are businesses like airline and cargo transportation companies and governments which predominantly seek for defense and space related products. Headed by two industry giants of commercial aircraft (CA) manufacturing Airbus and Boeing[4], major aerospace firms in the world are mainly composed of defense contractors of military aircraft manufacturing which are followed by aircraft engine manufacturers, other commercial aircraft producers of small aircraft segments and major components and systems suppliers.

The history of aviation and aerospace manufacturing is an account of a colossal set of innovative efforts and their mass utilization in transportation and defense which have long been the two main sources of any form of economic and technological development in the history of humankind. Even communication, another major source, had long been an integral part of transportation and defense. Although the commercial utilization of the invention of heavier-than-air aircraft was initially for mail transport between different cities, air travel and air defense quickly became primary goals of further innovation in aircraft design and development for more than hundred years up until today.

Thus the rapid increase in airmail transport and air travel quickly transformed aircraft manufacturing from an activity mainly held behind the closed doors of the workshops of

[4] Commercial aircraft segment of aerospace industry consists of the production and sales of jet aircraft of more than 100 seats.

aviation enthusiasts to a large-scale industrial enterprise leaded by industrialists. The industry followed a similar path of development with other new industries of the twentieth century with some particular features. Together with its revolutionary impact on human transport, its firm connection to defense industry and national security is peculiar. Quick adoption of aircrafts as an integral element of wars and conflicts around the world made their industries strategic elements of so-called national military-industrial complexes of the early twentieth century.

A major feature of the industry is the massive scale of investment needed to produce the commercial or military aircraft, the final product with all systems and components installed. Much more complicated than other manufacturing industries, the final product is composed of millions of different pieces manufactured. The integration of this massive number of components require a substantial set of design, development and manufacturing capabilities with necessary capital and human resources investment. As an example, one out of six manufacturing sector engineers in the US works for the aerospace industry. Another example, Boeing Everett factory where several aircraft models of Boeing are assembled is the biggest building in the world in terms of volume and floor area.

As a result, aerospace is one the most pronounced sectors of economic activity in stressing the collective and cumulative character of innovation. Despite a limited room of ruptures and radical innovations since the early days of aviation, the control of original equipment manufacturers (OEMs) over the course of innovation throughout the value chain is decisive. Besides, they are strictly responsible of the resilience of the supply chain, continuous inflow of skilled and qualified workforce with up-to-date knowledge, necessary financial and organizational commitment to launch new product development initiatives, and close coordination with customers. Their projections based on their innovative capabilities and product market estimations design the long-term structure of the entire industry from small scale component manufacturers to full systems developers. These organizations closely follow OEMs' projections to build their decisions over capital spending, recruitment and further investment on their workforce. These interdependent aspects are equally important for organizational success of OEMs and resulting economic prosperity for all the stakeholders involved. For example, without detailing the transformation of the supply chain and its geographical evolution in time, the questions over the conditions of domestic workforce cannot be identified. Equally, without detailing the role of financial commitment of different stakeholders in innovation, the true forces behind the innovative capabilities of business firms cannot be established. In order to explore the dynamics of productive activity within a specific field, each aspect should be elaborated in great detail along empirical analysis.

Even though it is slower than many other industries, the geography of aerospace also gradually evolves. Historically restricted to advanced economies with superior technological and industrial capabilities required to maintain a network of aerospace suppliers organized around a small number of OEMs, the industry has been emerging as a global business with substantial efforts of developing economies. They either try to position in specific domains like materials, electronics and other specialized systems or support national companies with an aim to develop and manufacture final products in order to compete with established manufacturers of the West. Slowly integrated in established supply chains, these countries and their respective corporations have characteristic aims jointly shared: To upgrade productive capabilities and to become either an essential link in the supply chain with indispensable capabilities for OEMs or to produce the final product with domestic content as extended as possible.

However, these efforts are gradual and slow. Top military and civil aerospace companies are still dominantly concentrated in the developed world. Among the top 100 world aerospace companies identified by PwC, there are only six aerospace companies from developing economies (Flight International, 2015). Table 2.1 presents the top 25 aerospace companies in the world in three parts. The first part (2.1a) compares compounded annual growth rates of basic revenue, investment and employment indicators. The second part (2.1b) compares selected profitability and payout ratios. Finally, the third part (2.1c) compares their most recent ownership structures. Thanks to the particularly giant US defense budget they trade on, American companies are overrepresented while the UK and France are the only countries represented with more than one company. Several different investment, performance and shareholding indicators represent a heterogeneous group with considerable divergence.

Employment growth on average falls behind total or aerospace revenue growth during the period which implies rising productivity and potentially increasing outsourcing among OEMs. In contrast to the negative employment growth of several OEMs in the list which are predominantly from the US, above average growth in several component and systems providers is striking. Nevertheless, major US systems providers like Honeywell and Rockwell Collins stay behind despite remarkable employment growth of other US or non-US suppliers.

One interesting observation is the smaller growth of R&D and capital expenditures compared to revenue growth on average. Superior growth of payouts in the form of share repurchases and dividend payments resulted in smaller investment in capabilities. Growth in share repurchases is particularly spectacular which is five times superior to the revenue growth during the period. The last three columns of 2.1b show that the total payout (dividends and share repurchases as a percentage of net income) of many US companies is either close or superior to 100 percent during the period. Because of the limited share repurchase activity of non-US companies, their payout levels remain inferior. Their main form of shareholder value distribution is dividend payments.

Despite inconsistencies of the database which are reflected in higher ‘Other’ percentages especially for non-US companies, the divergence between companies is also represented in ownership concentration, shareholding of distinct actors like State, insiders or hedge fund managers and the total share of top aerospace and defense institutional investors. One observation: Top five aerospace investors hold between 10 to 30 percent of all US companies in the list while their holdings among non-US firms are to a great extent inferior.

Table 2.1a: Compounded annual growth rates of principal indicators of top 25 aerospace companies worldwide between 2000 and 2014 (in %)

	Year Founded	Home Country	Work force	Total Revenue	Aerospace Revenue	Net Income[1]	Research and Dev.	Capital Expend.	Total Assets	Total Debt	Cash	Total Dividends	Total Share Rep.[1]
Boeing	1916	USA	-1.19	3.87	3.87		2.85	6.01	5.89	0.20	17.76	10.03	
Airbus	1970	Europe	3.01	8.13	8.13		8.20	4.95	7.57	3.35	7.34	23.74	
Lockheed Martin	1995	USA	-0.78	4.00	4.00		-0.82	3.56	1.34	-3.14	-0.27	16.29	
United Technologies	1934	USA	2.15	6.15	7.42		4.81	4.10	8.91	9.89	13.85	11.75	
BAE Systems	1999	UK	-0.12	3.47	-		-0.47	-2.05	1.14	0.06	3.31	7.60	
General Electric	1917	USA	-0.17	0.90	5.48		5.61	-0.12	2.66	4.05	14.30	3.35	
Northrop Grumman	1994	USA	3.34	7.94	7.94		-4.95	4.89	7.01	9.06	18.09	11.23	
Raytheon	1922	USA	-2.82	2.03	2.30		-0.34	-1.84	0.27	-4.06	9.11	6.85	
General Dynamics	1899	USA	5.70	7.55	8.26		6.31	4.03	10.43	14.67	23.87	9.81	
Safran*	2005	France	1.91	3.98	5.47		9.03	6.76	3.67	5.27	3.93	12.27	
Finmeccanica**	1948	Italy	1.47	6.21	8.25		4.55	6.93	5.25	9.14	4.65	-	
Thales	1893	France	0.39	4.55	-		5.01	2.75	2.69	-3.06	6.82	7.82	
Honeywell	1906	USA	0.11	3.23	3.02		5.75	1.67	4.02	2.94	12.46	6.36	
Rolls-Royce	1906	UK	1.43	6.13	4.86		2.11	6.76	8.56	3.85	12.67	12.32	
L-3	1997	USA	8.10	13.11	13.11		5.58	11.96	12.19	8.91	18.96	-	
Bombardier	1942	Canada	1.63	4.27	2.70		10.07	14.02	4.83	1.92	6.97	2.00	
Textron	1923	USA	-4.79	0.39	3.17		-0.25	-1.36	-0.76	-4.10	6.56	-11.95	
Precision Castparts	1953	USA	5.09	10.21	10.21		-	11.39	14.43	10.31	17.9	7.31	
Spirit AeroSystems*	2005	USA	2.54	17.83	17.83		-10.15	3.39	12.05	4.81	4.59	-	
Embraer	1969	Brazil	4.20	5.24	5.24		-5.21	6.34	9.65	11.73	2.44	-1.89	
Zodiac	1929	France	7.40	10.94	12.99		36.15	9.52	10.68	5.64	11.00	13.44	
Rockwell Collins	2001	USA	0.89	4.67	4.67		3.39	3.45	8.42	-	20.38	17.47	
United Aircraft Corporation	2006	Russia	n/a	n/a	n/a		n/a	n/a	n/a	n/a	n/a	n/a	
MTU Aero Engines	1968	Germany	0.44	5.49	5.49		6.95	2.20	10.15	36.19	7.92	-	
Mitsubishi Heavy Ind.**	1884	Japan	2.25	3.24	-		-2.61	2.12	3.07	-1.20	5.01	4.47	
Total of 21 companies* between 2002 and 2014**	**-**	**-**	**0.84**	**4.83**	**5.20**	**17.18**	**2.71**	**3.70**	**4.65**	**1.89**	**9.44**	**8.65**	**23.10**

[1]Single company net income and share repurchase CAGR values are not calculated because they occasionally give not-so-meaningful figures due to negative net income values and zero repurchases of several companies for specific years, *CAGR between 2005 and 2014, **CAGR between 2002 and 2014 due to some missing values prior to 2002, *** General Electric is excluded from the total due to its smaller focus on aerospace compared to other companies. Safran, Spirit AeroSystems and United Aircraft Corporation are also excluded due to their missing values before 2005, 2005 and 2008 respectively,

Source: CapitalIQ and company annual reports

Table 2.1b: Average profitability and payout ratios of world's top 25 aerospace companies between 2000 and 2014 (in percentages except inventory turnover and current ratio)

	Gross Profit Margin	Net Income Margin	ROE %	ROA %	Return on capital emp. (ROCE) %	Inventory Turnover	Current Ratio	Debt-to-equity %	Diluted EPS Excl. Extra Items	Price-Earnings Ratio	Total Dividends / NI[1]	Share Rep. / NI[1]	Total Payout / NI[1]
Boeing	16.4	4.2	63.2	4.1	6.4	4,9x	1,0x	196,8	3,8	21,6	0.37	0.59	0.95
Airbus	15.7	1.3	6.0	1.0	1.5	4,7x	1,8x	47,9	1,1	26,1	0.41	0.26	0.67
Lockheed Martin	8.7	4.5	79.4	6.5	10.4	15,4x	1,1x	1216,0	5,5	32,8	0.36	0.69	1.05
United Technologies	28.0	7.9	22.4	8.0	12.3	5,2x	1,3x	52,1	4,0	17,1	0.29	0.35	0.65
BAE Systems	43.2	2.9	11.2	2.9	4.6	9,2x	0,8x	74,9	0,2	-45,0	1.02	0.30	1.32
General Electric	37.0	10.2	16.5	1.9	3.0	6,0x	2,0x	360,4	1,5	18,6	0.52	0.31	0.83
Northrop Grumman	19.3	4.9	11.3	5.5	8.7	21,2x	1,2x	42,6	4,6	13,1	0.33	0.89	1.22
Raytheon	19.5	5.0	13.0	5.5	8.8	33,3x	1,5x	51,1	3,4	292,9	0.40	0.61	1.01
General Dynamics	13.9	6.9	19.0	7.8	11.8	11,9x	1,3x	34,0	4,4	9,1	0.28	0.43	0.71
Safran*	43.7	2.6	6.9	2.0	3.3	2,0x	1,0x	53,3	1,2	152,4	0.60	0.04	0.64
Finmeccanica	38.0	1.8	2.8	1.6	2.0	1,5x	1,1x	97,1	0,4	-1,2	0.88	0.00	0.88
Thales	22.2	2.5	9.5	1.9	3.0	3,9x	1,0x	79,5	2,1	10,0	0.45	0.07	0.52
Honeywell	24.4	6.0	18.2	6.5	10.1	6,4x	1,4x	62,3	2,5	-10,3	0.44	0.43	0.87
Rolls-Royce	19.8	5.6	16.3	3.4	5.2	3,8x	1,5x	52,6	0,5	0,8	0.31	0.08	0.39
L-3	11.6	5.5	13.0	6.4	9.6	38,0x	2,0x	80,8	5,5	17,9	0.18	0.69	0.87
Bombardier	13.9	1.8	8.9	2.6	4.1	2,9x	1,3x	1184,4	0,2	12,5	0.56	0.13	0.69
Textron	19.1	2.8	11.7	3.4	5.3	4,3x	2,0x	212,5	1,4	20,9	0.33	0.67	1.00
Precision Castparts	27.4	11.4	16.5	10.3	15.5	3,9x	2,2x	39,1	5,5	20,9	0.02	0.19	0.21
Spirit AeroSystems*	11.2	2.0	8.6	3.9	5.1	2,5x	2,8x	78,2	0,5	38,9	0.00	0.15	0.15
Embraer	26.1	8.2	20.7	6.1	8.8	1,9x	1,8x	70,2	0,5	19,1	0.35	0.04	0.39
Zodiac	55.6	8.4	15.3	6.9	10.5	2,2x	2,1x	98,2	0,8	16,8	0.28	0.05	0.32
Rockwell Collins	28.4	11.6	36.5	11.1	17.0	3,1x	1,6x	33,2	3,0	17,6	0.22	0.65	0.87
United Aircraft Corp. **	17.4	(2.4)	(11.4)	0.4	(0.4)	1,1x	1,3x	233,7	n/a	n/a	0.00	0.00	0.00
MTU Aero Engines***	15.9	4.7	30.2	5.1	8.5	3,7x	1,0x	48,9	3,8	19,7	0.27	0.14	0.41
Mitsubishi Heavy Ind.	14.6	1.4	3.1	1.6	2.6	2,3x	1,5x	86,2	0,1	44,7	0.41	0.00	0.41

[1]Total payout ratios for the whole period *Averages between 2005 and 2014, **Averages between 2002 and 2014, *** Averages between 2001 and 2014

Source: CapitalIQ and company annual reports

Table 2.1c: Top 20 Aerospace companies' share ownership structures as of mid-2015

	Ownership concentration (total share of >5% shareholders)	% share of ESOP / 401(k) PMT / Employees	% share of Traditional Investment Managers*	% share of the State (only home country)	% share of insiders (chairpersons & executives.)	% share of corporations	% share of Banks/ Investment Banks	% share of Hedge Fund Managers	% share of Others**	Total share of Top 5 A&D institutional investors***
Boeing	26.70	6.50	61.80	0.00	0.08	0.00	3.50	1.20	27.10	25.20
Airbus	21.80	2.10	44.50	25.90	0.01	0.00	0.00	0.00	27.40	11.00
Lockheed Martin	39.90	14.20	63.60	0.00	0.04	0.00	3.70	0.60	17.80	29.50
United Technologies	18.20	7.10	65.60	0.00	0.16	0.00	5.00	1.60	20.50	18.60
BAE Systems	18.60	3.60	75.40	0.00	0.09	0.07	2.00	0.20	18.40	13.50
General Electric	11.10	0.00	49.10	0.10	0.06	0.00	3.00	1.10	46.70	16.40
Northrop Grumman	32.90	7.40	81.80	0.20	0.70	0.00	2.60	1.80	5.60	19.10
Raytheon	15.00	0.00	71.20	0.10	0.45	0.00	4.90	2.90	20.50	18.60
General Dynamics	44.70	7.80	74.70	0.20	5.80	0.00	2.90	3.10	5.50	22.90
Safran	25.40	13.80	38.50	18.00	0.05	0.00	0.00	0.20	29.40	7.60
Finmeccanica	32.50	0.00	22.00	32.50	0.00	0.00	0.00	0.00	45.50	1.20
Thales	51.50	2.00	20.40	26.30	0.00	25.25	0.00	0.00	51.30	2.40
Honeywell	21.20	5.00	71.20	0.00	0.20	0.00	3.70	1.10	18.80	17.40
Rolls-Royce	16.80	1.20	72.60	0.00	0.06	0.00	2.60	0.00	23.50	5.80
L-3	28.60	0.00	73.40	0.00	0.80	0.00	0.80	2.80	20.00	14.10
Bombardier	7.40	0.00	27.50	0.00	12.57	0.00	0.00	0.30	59.60	2.40
Textron	33.70	0.00	75.90	0.10	0.30	0.00	0.90	3.70	19.20	30.90
Precision Castparts	25.10	0.00	71.50	0.10	0.23	0.00	2.40	10.00	15.90	29.60
Spirit AeroSystems	25.70	0.00	55.80	0.00	4.06	0.00	1.80	41.00	0.00	12.60
Embraer	46.00	0.00	74.40	11.20	0.00	0.00	1.50	0.30	12.60	9.10
Zodiac	19.30	1.00	33.80	0.00	9.88	11.80	0.00	0.00	55.30	2.40
Rockwell Collins	23.20	0.00	70.70	0.10	0.28	0.00	2.20	1.80	25.00	23.60
United Aircraft Corp.	94.00	0.00	0.10	94.00	0.04	0.15	0.00	0.00	5.90	0.00
MTU Aero Engines	5.30	0.00	60.80	0.00	0.00	0.00	0.00	2.50	36.70	6.50
Mitsubishi Heavy Ind.	10.8	0.0	20.2	0.0	0.02	8.45	17.3	0.1	62.4	4.4

*Traditional Investment Managers include firms managing "traditional" portfolios of stocks and bonds such as pension funds, foundations, or endowments (CapitalIQ). **Others include Venture Capital/Private Equity firms, Family Offices/Trusts, Government Pension Sponsors, Corporate Pension Sponsors, Insurance companies and other unidentified institutional or individual shareholders. *** Top 5 A&D institutional investors include The Vanguard Group, BlackRock, Capital Research and Management Company, Wellington Management Company and T. Rowe Price Group

Source: CapitalIQ and company annual reports

2.2 Defense connection

With a diverse range of technologies utilized and markets served, aerospace industry has strong connections with a big number of high-tech industries. Many aerospace companies serve for several different product markets and supply chains of aerospace OEMs contain many non-aerospace firms providing goods and services to help build the final product.

However, the relationship of aerospace sectors with the defense industry has been rather symbiotic than cooperative. Even though the global defense and military aerospace industries in general follow their own logic with respect to product range and sales performance as long as the development costs of new products are covered by governments which are the principal source of demand for their products, many of the biggest companies operate in both military and civil segments with a greater concentration on one or the other. One major explanation of the persistent coexistence of civil and military segments within companies is to take advantage of newly developed technologies in each segment. Another explanation is the governments' support schemes and allowances in specific areas that allow or even promote multiple uses of existing or future technologies.

Dating back to early years of aviation, the "dual-use" of new technologies at systems level and the spillover effect of military designs on civilian aircrafts have remained as major patterns of aerospace-defense symbiosis with changing dynamics. Major systems level examples in the history of aerospace are Boeing B707, CASA CN235 and AgustaWestland AW609 (formerly Bell/Agusta BA609) which were previously designed and built for military purposes and later converted into commercial aircrafts for civilian use. In the systems level, examples of dual use are much more numerous. The first widespread success of the civil applications of technological systems developed through military contracts was in computers, nuclear energy and aerospace in the early years of the after-war period. It was followed by a second wave of migration of military research results in electronics, satellite technology and ICT to civil applications including the internet, advanced avionics systems, composite materials, GPS navigation, touch screens and numerous other applications. Later in the 1990s, US and European governments initiated explicit dual use support programs (Braddon, 1999; DoD, 1997) which eventually became integral as part of a strategic vision of subsequent research programs supported by defense and space programs by governments (Fiott, 2014) as a means to address rising defense R&D budgets and increasing international competition around leading edge technologies. Commercial gains expanded to a large array of applications at subsystem levels, materials or process technologies also in the aerospace industry. Given the high degree of civil and military aerospace integration in the US, American companies acquired important technology gains from military-funded R&D in specific fields including avionics and materials while such opportunities remained limited in scale and scope in Europe (Braddon, 1999).

Massive investment in military R&D and its migration to civil applications also helped companies to accumulate a tremendous knowledge base which can be reused for defense applications for the second wave of innovation. One latest trend in military applications in aerospace is the continuing convergence of the roles of defense and security into a single group of customer needs (Airbus, 2013 FR) with an increasing utilization of civil applications like intelligence, surveillance, secure communications and electronics. Dual use is especially highlighted in such areas due to the nature of technology which is open to widespread application with a broader range. Thus the military has changed its design philosophy, using commercially available, off-the-shelf technology when appropriate, rather than developing new customized components (BLS, 2006).

Meanwhile, beside this "spillover" effect of military technologies, civilian aerospace has also benefited considerably from technological developments in numerous other industries (Mowery and Rosenberg, 1982). Electronics, IT and composite materials have a rising share of applications within new civil or military aerospace products. Large aerospace firms became active developers and acquirers of such technologies (see mergers and acquisitions and joint ventures of Airbus and Boeing in Chapter Three; Esposito and Passaro, 2009) which were also supported by government funds. As a simple example, Department of Commerce’s Federal R&D support for composite manufacturing research in the automobile industry was later successfully utilized by aerospace industry (Braddon, 1999).

Moreover, the transfer of military technologies to civilian uses is not always one way. In many cases, civilian products are being extensively used for military purposes after necessary redesign and modifications. As a comparison, Boeing is much more advanced in utilizing similar technologies and platforms for both commercial and military uses compared to Airbus.

Beside a much broader product range in defense, security and space segments, it has also been highly successful in converting available commercial products for military uses thanks to keen government demand for such aircraft. Boeing's commercial to defense conversions include 737 Airborne Early Warning and Control aircraft (14 built until 2015); C-40 Clipper military transport aircraft (23 built until 2015); and P-8A Poseidon antisubmarine and anti-surface warfare aircraft (27 built until 2015) converted from Boeing 737, and KC-46 Pegasus military aerial refueling aircraft converted from 767 (11 built for non-US customers and 179 ordered/optioned by US Air Force). Airbus has only A310 MRTT (6 built until 2015) and A330 MRTT (22 built until 2015) aerial refueling aircraft conversions in use.

2.3 Demand, Product Markets and Competition

As previously stated, aerospace and commercial aircraft manufacturing sectors mainly produce capital goods for government and business organizations. A particular feature of the industry is the small lot size of final products. Together with rising technological complexity and higher development costs, a small market of aerospace final products imposes a highly concentrated industrial structure with a very limited number of final product manufacturers in each segment of the industry. In specific segments the market may also be controlled by a single supplier for temporary or prolonged periods which provides a monopoly power. Examples include Boeing's monopoly over wide body long range segment of commercial aircraft up until late 2000s with its 747 model and Russia's current monopoly on human spaceflight which is provided by Soyuz rockets and crew capsules. Thus the level of competition is a controversial issue in civil and military aerospace. Due to their distinct character, as the demand is substantially composed of government contracts, the rivalry in defense and space segments mainly restricted to a competition between national firms. As an example, Table 2.2 shows the share of biggest US and non-US top aerospace and defense contractors for a selected group of US departments having highest obliged amounts in aerospace and defense. In 2013, procurement from non-US firms and organizations constituted only around 8 percent of the total defense and space spending of the US government among these departments.

Table 2.2: Share of top 100 US and non-US contractors for the major US aerospace and defense purchasing departments by dollars obligated in 2013

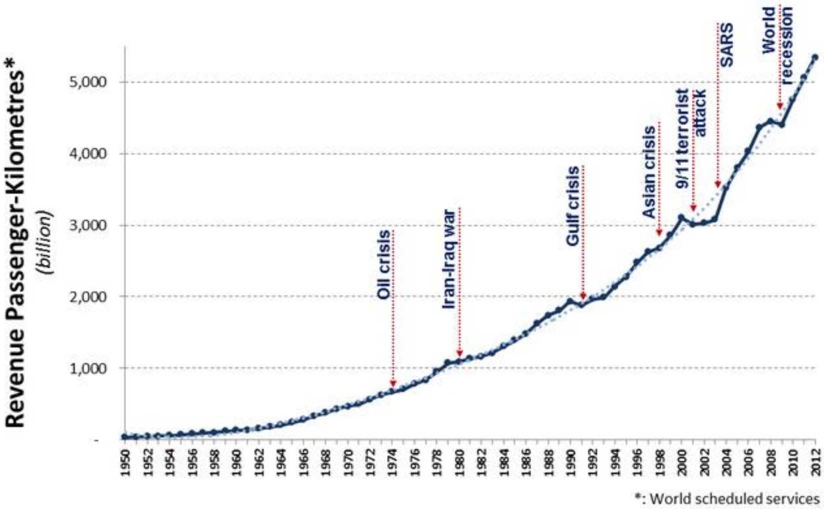
Department	Total amount obliged by the department (in millions USD)	% share of the amount obliged to US organizations	% share of the amount obliged to non-US organizations	# of non-US firms in top 100 contractors
DoD	202 419	91,9	8,1	20
US Navy	73 344	94,9	5,1	9
US Army	54 340	93,8	6,2	11
US Air Force	45 953	95,7	4,3	12
Defense Logistics	25 234	63,0	37,0	31
NASA	13 384	96,1	3,9	4
Homeland Security	8 335	89,5	10,5	11
Missile Defense	7 610	99,9	0,1	4
Defense Information	4 103	92,5	7,5	9
US Special Operations	2 358	98,0	2,0	6
Defense Commissary	1 399	94,6	5,4	11
Defense Threat Reduction	914	95,2	4,8	7
DARPA	704	87,8	12,2	7
Defense Contract Management Agency	521	86,8	13,2	7
Defense Microelectronics	520	81,3	18,7	9
DoDEA	229	48,4	51,6	39
Defense Finance	142	82,3	17,7	9
Defense Media	91	96,5	3,5	7
Defense Security	61	93,8	6,2	17
TOTAL as a group	**441 661**	**91,6**	**8,4**	

Source: US General Services Administration Federal Procurement Data System

The long-term market for aerospace and defense products and services also depends primarily on the characteristics of demand for each segment. In the case of military aerospace segments of the defense and security market, major drivers of demand are mainly restricted to political decision-making on defense and security spending and corresponding size of budgets. One major effect of the latest economic and financial crisis has been the pressure to reduce defense spending and the reduction in defense budgets in the West. In effect, between 2010 and 2014, OECD defense budget R&D as a percentage of total government budget appropriations or outlays has decreased from 28.6 percent to 23.4 percent (OECD, 2015). Continuing convergence of the roles of defense and security has also an impact on industrial integration and resulting product range. Whether the global progress of budget cuts in defense and security spending is still blurry, the impact of such cuts on industrial performance and its subsequent reorganization may also have a great impact over marketing strategies of aerospace firms with varying performance figures. The rapid decrease in military spending during the post-Cold War period, resulted in a massive consolidation of aerospace industry both in the US and in Europe which also reorganized the commercial segments of the industry around a handful of companies resulted in duopolies in major segments like commercial aircrafts or oligopolies in general aviation or helicopters. As a result, very high levels of producer concentration continue to persist in each segment.

In the commercial and civil aviation segments, however, manufacturers compete on a global scale. The main determinant of the aircraft market and the demand for new aircraft in different sizes and configurations is the performance of the airline industry and their long-term fleet planning. Mainly based on air traffic forecasts and trend estimates, CA manufacturers regularly publish market forecasts on demand for passenger aircrafts in different seating categories. Any change in national and international regulations on safety, emissions, noise limits and the rate of replacement and obsolescence of existing fleets of airline companies are also influential. Manufacturers base their decisions to increase or decrease their output on their existing orders as well as market outlook for their specific products. Such estimates are also important indicators to launch a new product in a specific CA segment as well as the interests of airlines to order new aircraft. Commercial airlines base their decisions to purchase a new aircraft model on a number of factors such as routes they fly, aircraft range, size, cargo capacity, type of engine, and seating arrangements and the selection is ultimately based on a manufacturer's ability to deliver a reliable aircraft that best fit the purchaser's stated market needs at the lowest cost and at favorable financing terms (BLS, 2006). Overall health of the economy, fuel prices, interest rates, and consumer confidence are also influential (Tortoriello, 2010). Airlines placing initial orders had and still have extensive power to dictate the performance characteristics which differ substantially depending on the route structures and technological preferences. Their commitment to purchase a specific number of aircrafts of the new model and their initial payments help manufacturers to reduce market uncertainty. Their expectations in terms of product performance, quality, and overall value have long been on the rise. They expect very high utilization of each aircraft to recover their investment requirements. For this reason, reliability and safety are rigorous. Moreover, an airline customer may expect decades of on-going technical support for maintenance, repairs, and further modifications (Sorscher, 2011). Explained by the gradual increase in commercial aircraft deliveries and the so-called democratization of air transport since the 1970s, the growth of air transport outpaced the growth of the broader global economy. Between 1995 and 2012, the world GDP grew at an average annual rate of 2.8 percent while the world passenger air traffic expressed in revenue passenger-kilometers increased at an average annual growth rate of 5 percent (ICAO Facts and Figures, 2014). However, the growth of air transport was disrupted by several slowdowns directly or indirectly related to aviation. Figure 2.1 shows world air transport revenue between 1950 and 2012 with major disruptions which led to one or more years of recession in the air transport business.

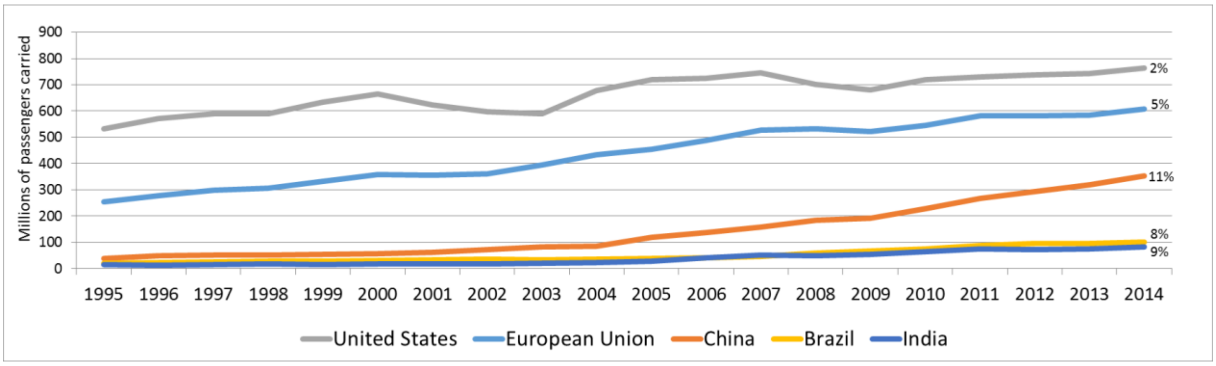
Figure 2.1: The course of world air transport in terms of revenue passenger-kilometers growth, 1950-2012



Source: ICAO web site, retrieved in December 2014

The strong increase in air travel demand in the last two decades can be explained by two major factors. The first one is the rapid rise of air travel in developing economies and particularly in China. As of 2014, in the top 10 list of airlines by international and domestic passengers carried, there are two European low-cost and three Chinese national airlines (IATA, 2015, from WATS 59th edition). Figure 2.2 shows the growth in air travel in a selected group of countries with their compound annual growth rates indicated in percentages. The growth in China surpassed any other country between 1994 and 2013 and the number of passengers carried by Chinese airlines experienced nearly a ten-fold increase. The second factor is the rise of low-cost airlines all over the world but especially in Europe. The substantial success of these carriers forced national airlines or flag carriers of the world to gradually introduce their own low-cost subsidiaries in order to compete in regional routes and short distance destinations. These new actors of the air transport industry quickly became a major source of demand for commercial and regional aircraft sales. During the same period the increase in Europe was also spectacular especially compared to the US as the figure shows.

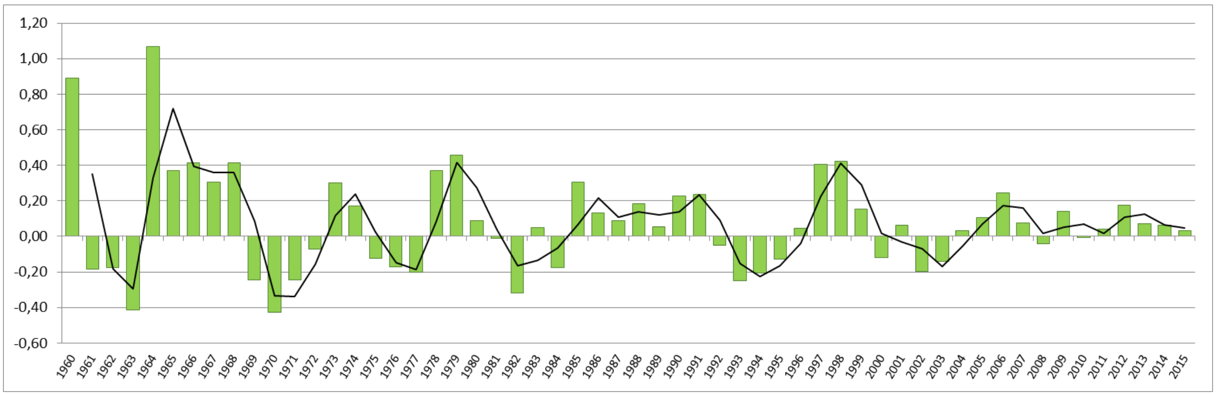
Figure 2.2: Growth in air transport by passengers carried in the US, the EU, China, Brazil and India; 1995-2014



Source: World Bank Development Indicators, 2015

A specific character of the aerospace industry is its cyclicality. As a capital-intensive industry, both civil and defense segments are subject to multiple-year fluctuations owing to either general economic downturns, volatility of airlines profitability, defense budget cuts or industry specific downturns which have important corporate or organizational level consequences on firms and their competitiveness. Figure 2.3 below show the year-to-year percentage change in total commercial aircraft deliveries in the US and Europe since 1960. Except unusually positive change in deliveries in 2009 which prevented another downward trend despite the fact that it was a year of global economic recession, the irregular cyclical nature of the industry can easily be followed since the early years of passenger jets. For the latest period, continuous growth in commercial aircraft deliveries during the recession is mainly explained by rising deliveries to Asia.

Figure 2.3: Year-to-year percentage change in total commercial aircraft deliveries in the world, 1960-2015

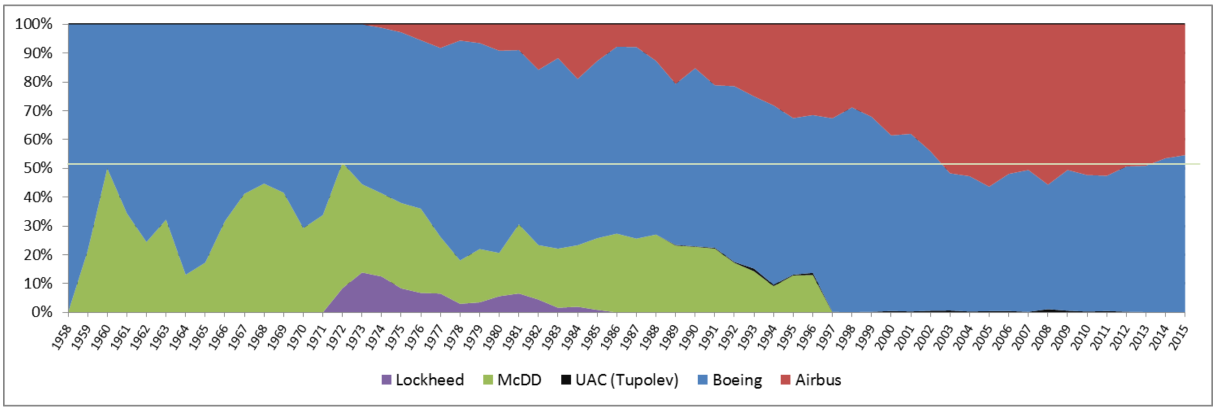


Deliveries include all Airbus, Boeing, McDonnell Douglas and Lockheed jet passenger models and Concorde (British Aircraft Corporation & Aérospatiale), Comet (de Havilland), Caravelle (Sud Aviation), Trident (Hawker Siddeley), VC-10 (Vickers-Armstrongs), BAC-111 (BAC), Mercure (Dassault Aviation), Convair 880 and Convair 990 (General Dynamics) models of their respective manufacturers. The curve indicates two-period moving averages

Sources: Baldwin and Krugman (1988); Airbus and Boeing company websites.

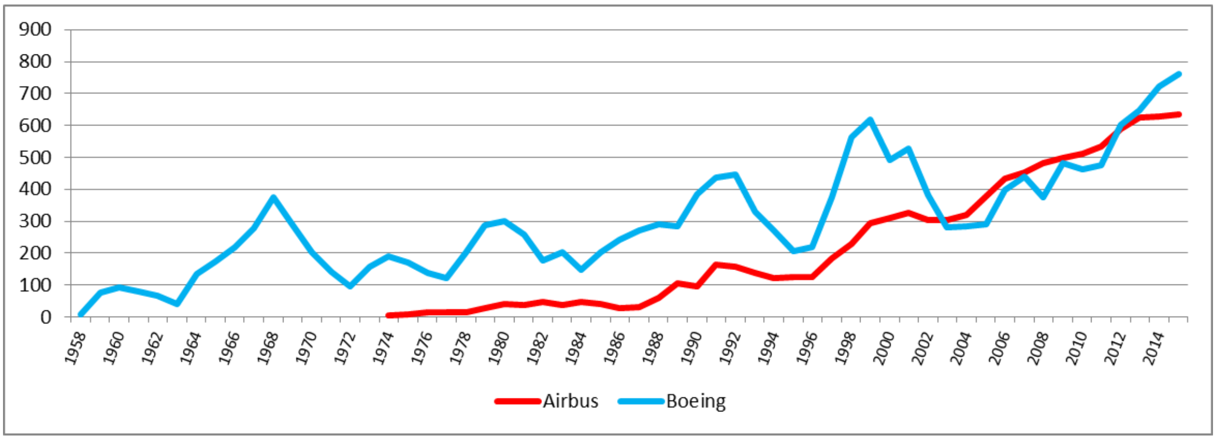
As of 2015, excluding miniscule sales of Tupolev Tu-204 predominantly in Russia by UAC, Airbus and Boeing represent a long-lasting equally shared duopoly of the commercial aircraft market which has had important consequences for the overall structure of the industry. Figure 2.4 shows the market share of major CA manufacturers since the introduction of the first jet passenger Boeing 707 in 1958, and Figure 2.5 shows the number of deliveries by Airbus and Boeing. Airbus and Boeing share the market almost equally for the last ten years. The cyclicality in aircraft sales is observed much more strongly in Boeing with multiple supply and demand related reasons including production stoppages due to supplier deficiencies, labor strikes, organizational issues arising from rapid ramp-up of final assembly and a sharp fall in domestic aircraft orders resulted in large-scale cancellations.

Figure 2.4: Commercial aircraft deliveries of major manufacturers, 1958-2015



Sources: Baldwin and Krugman (1988); Airbus and Boeing company websites

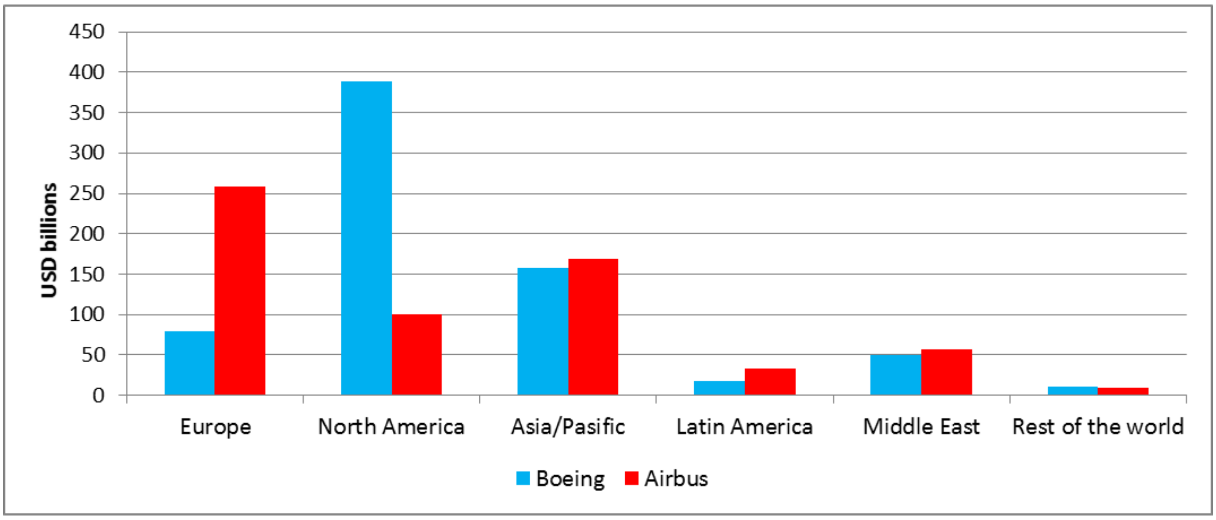
Figure 2.5: Number of Airbus and Boeing commercial aircraft deliveries, 1958-2015



Source: Airbus and Boeing company websites

This increase in air travel in specific regions is also reflected in sales to these economies by main CA manufacturers. Figures 2.6, 2.7 and 2.8 below show sales of Airbus and Boeing to specific regions for the periods with consistent and comparable sales figures available. The figures show that the competition between two companies is concentrated mostly in Asia/Pacific and Middle East regions. These regions continue to be cited as the highest growth markets for major aerospace companies (KPMG, 2012), and the share of these regions in total sales has substantially increased for both companies. Between 2000 and 2013, two regions' share in total sales of Airbus and Boeing increased from 10 and 15 to 42 and 39 percent respectively. While they continue to dominate their home markets, sales of Airbus and Boeing in their rival's domestic market proportionally decreased during the period. The scope of fierce competition, which is also the main source of decades-long subsidy conflict between the two companies, moved to the Asia-Pacific region. The two companies offer large price discounts to increase their sales volumes and maintain brand loyalty (Tortoriello, 2010). Thus, fierce price competition, very high levels of producer concentration and significant product differentiation as principal characteristics of the aircraft manufacturing continue to coexist more than thirty years after these characteristics were identified in the seminal work of Mowery and Rosenberg (1982) on the commercial aircraft industry.

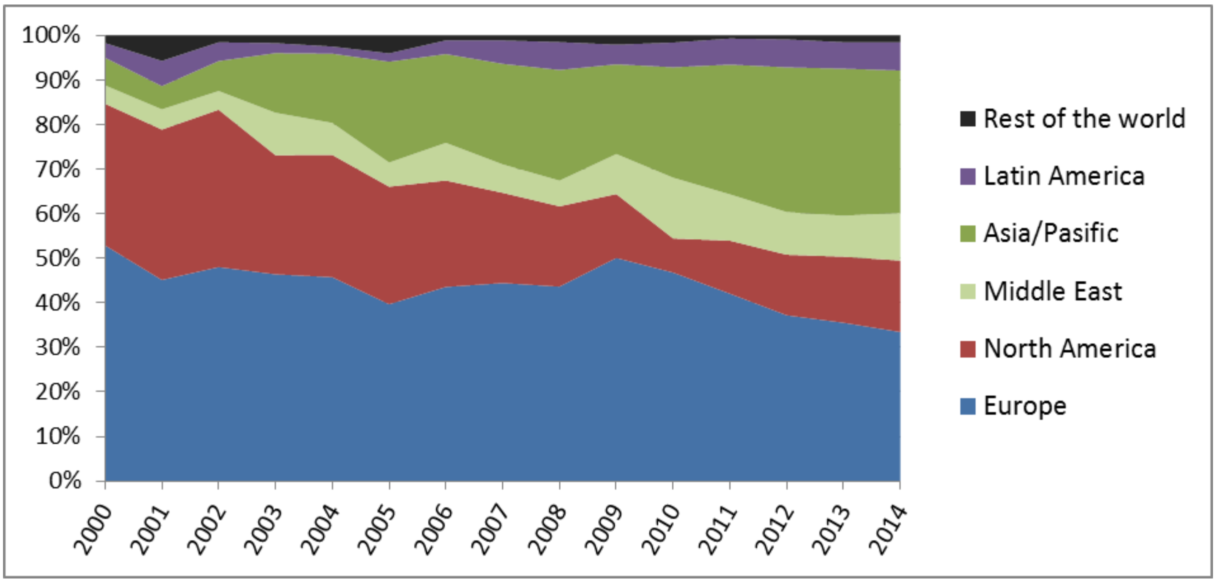
Figure 2.6: Geographical distribution of total revenue between 2005 and 2014 (10-year total)



Due to distinct regional calculations prior to 2005, sales figures before this year cannot be differentiated. The categorizations are based on Airbus' less detailed classification. In the case of Boeing, Airbus' North America group corresponds to Boeing's Canada and the United States; Airbus' Asia/Pacific group to Boeing's China, Rest of Asia and Oceania groups combined; Airbus' Latin America group to Boeing's Rest of Western Hemisphere group; and Airbus' Rest of the world group to Boeing's only remaining category Africa

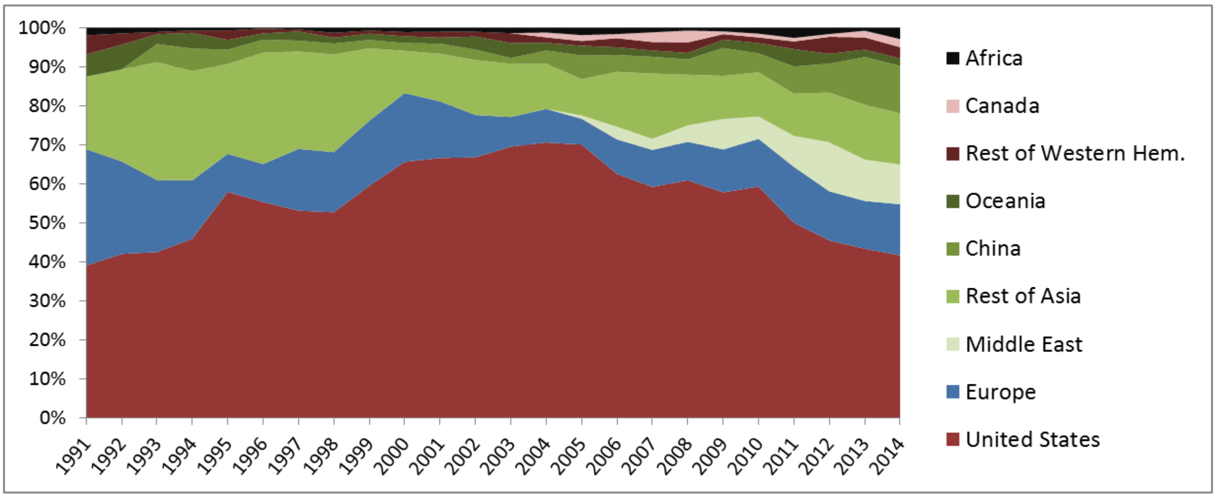
Source: Airbus and Boeing company annual reports.

Figure 2.7: Distribution of Airbus geographical segment revenue between 2000 and 2014



Source: Airbus annual reports

Figure 2.8: Distribution of Boeing geographical segment revenue between 1991 and 2014



Before 2005, Middle East was considered in Rest of Asia group and before 2004 Canada was in Rest of Western Hemisphere group *Source:* Boeing annual reports

2.4 Technological characteristics and product development

Development and manufacturing of civil and military aerospace products and services require advanced technology and quality requirements. The success of the sector mainly comes from the ability to benefit from technological developments in aviation and other industries based on substantial amounts of research initiatives of not only business firms but also public bodies like universities and government research institutes specialized in aerospace all over the world. Final products of aerospace can only be designed, developed and manufactured through the integration of colossal amount of knowledge generated by these different types of organizations.

Primary features of the product development and production process include:

• Product and process complexity – Following the massive integration of fundamental aerospace technologies with new technologies in other domains including but not limited to advanced materials, electronics, navigation and communications, aerospace industry today has a very high level of process and product complexity which has important implications over the industrial organization. In commercial aircrafts, the latest trends of new technology integration are widespread use of composite materials as a substitute to heavier metals and alloys, and replacement of aircraft systems utilizing hydraulic power to carry out major tasks like air pressurizing, air conditioning, flight control and operations with alternative systems dependent on electricity power. The efforts of global aerospace companies to tap these technologies are gradually changing the structure of the industry. Different than prior times when most of the product development and manufacturing was performed in-house, mounting technological complexity to design and produce advanced components and systems has resulted in a complex web of production processes despite continuing efforts of OEMs to simplify their value chain networks.

The dynamics of the integration of civil and military technologies and applications in different fields of aerospace continue to dominate new product development efforts as well.

• Systems-type products – As a result of this technological super-integration, final products carry distinct features that have to be integrated, tested and utilized simultaneously. Major systems integrated to primary aerospace products like aircraft, spacecraft, satellites or missiles include structures, propulsion, flight controls and avionics, environmental control, navigation and communication systems and electrical network. The result is the growing role of suppliers of these systems which creates an established hierarchy within the supply chain as these systems providers have started to dictate their own specifications to lower-tier suppliers and cut their direct access to OEMs through their own contracts.

• Very high development costs – A colossal scale of technological integration together with ever-growing safety, quality and performance requirements result in a spectacular rise in development costs for aerospace products as well as new aircraft models. Table 2.3 shows the exponential rise of development costs of commercial aircrafts since the early days of commercial aircraft manufacturing. The increase in costs after the integration of jet engines and advanced electronics together with other war-tested technologies after 1950s is especially remarkable. Nowadays, major aerospace companies devote a considerable amount of their revenues in R&D expenditures. This ratio is usually higher for civilian aircraft manufacturers as R&D costs for military aerospace products are generally externally financed. Suppliers have also started to devote bigger resources to research and development as they are more responsible with design and development. For substantially high-cost products with considerably large production runs like commercial aircraft, a certain amount of costs is incurred indirectly by the acceptance of losses during the initial phase of the learning curve (Baldwin and Krugman, 1988). One time charges due to unexpected development issues and resulted delays are also prevalent.

Table 2.3: Selected commercial aircraft development costs

Model	Entered service in	Development costs in current USD (millions)	Development costs in 2009 USD (millions)	Implicit Price Deflators for USA GNP (2009 = 100)
DC-3	1936	0,3	3,8	7,99
DC-6	1947	14	109	12,86
DC-8	1959	112	651	17,20
Boeing 747	1969	1200	5555	21,60
Boeing 777	1995	6000	7969	75,29
A380	2008	15500	15619	99,24
Boeing 787	2011	18000	17402	103,44

Source: Original DC-3, DC-6, DC-8 and Boeing 747 figures are from *Competing Economies: America, Europe and the Pacific Rim* (1991), report prepared by the US Congress Office of Technology Assessment. 777, 787 and Airbus A380 figures are estimates published by various business sources. Estimates of the last three programs do not include extra payments due to delays, work-in-process inventory and supplier advances. Figures for GNP Deflator are taken from US Department of Commerce, Bureau of Economic Analysis database

Learning curve

Popularized later by mainstream economics in their effort to interiorize knowledge into the production process (Arrow, 1962), learning is a critical feature of any productive activity, particularly relevant in commercial aircraft manufacturing. For the industry, learning curve shows the change in productivity gained through the learning process with cumulative production. It was observed first in military aircraft production (Wright, 1936) and studied by various economics scholars in the US after it received attention during the Second World War as US government contractors searched for ways to predict costs and time requirements for construction of military ships and aircraft (Yelle, 1979). Introduction of new products with intervals characterized by new technological content; massive development costs of these products and skilled labor force which requires constant training with progressive returns make aircraft manufacturing an excellent case of application of learning curves. These curves are represented in percentages and the 80 percent learning curve became an industry standard suggested by industrial experts (Hartley, 1965; Irwin and Pavcnik, 2004) and studied with empirical data with substantially similar figures (Benkard, 2000). It means that as the number of aircraft manufactured is doubled, the direct labor input per aircraft declines by 20 percent. Besides the increase in direct labor productivity based on workers' skill and efficiency through multiple repetition and dexterity; the complexity of the design, the introduction of modifications to existing design in production, regular organizational changes, inspections and controls in the shop-floor and any discontinuities in the production may impact the curve adversely or favorably (Benkard, 2000; Hartley, 1965). Learning is not only limited to technical aspects of manufacturing. It can also be managerial and organizational (Hickie, 2006). Increasing outsourcing and strategic manufacturing alliances specifically highlight the collective character of learning and its managerial and organizational aspects. Finally, Benkard (2000) also shows the potential impact of human capital depreciation or 'organizational forgetting' on production performance when learning spillovers are incomplete. Critiques, however, emphasize that such studies of manufacturing productivity with estimated learning curves fail to include industrial-relations factors, and they may suffer from omitted variable bias and thus overstate the effect of the learning curve and other production processes (Kleiner et al., 2002).

• Design-intensive process – Product development in aircraft and engines incorporates a rather long design period in which producers search the possibilities to integrate the newest technologies. Although breakthroughs are continuously sought for superior performance and efficiency, most of the technological breakthroughs are still introduced incrementally (Hoag, 2000). Decisions about the moment when specific technologies are mature enough for application rest on careful monitoring and call for fine judgment (McIntyre, 1992). Manufacturers monitor each other closely and redesign their running development programs in case of technical reconsiderations. As an example Airbus decided first to switch back from already designed lithium-ion batteries on A350 XWB to nickel-cadmium ones following defects on lithium-ion models used in Boeing's 787 Dreamliner which caused the entire 787 fleet to be grounded for around three months in early 2013. However, in late 2014, the company decided to bring back lithium-ion batteries beginning with 2016, ensuring safety and certification. Capabilities that enable an aerospace firm to manage each phase from initial design to assembly including later stage product improvements are highly decisive on commercial success considering the magnitude of a new development program. In commercial aircraft manufacturing, potential stretching for different seating configurations, updates of existing models and additional uses of existing commercial programs like freighters, aerial refueling, airborne early warning and control and executive aircrafts are also important. Design work is extended to entire life course of an aircraft or an engine. The power of a design is hidden in its potential to scale itself into different directions in order to meet a variety of user needs (Frenken and Leydesdorff, 2000). This power provides to the firm an important degree of competitive advantage as long as it guarantees more orders from customers and reduces down its production costs along the learning curve.

• Relatively low production rates and high customization – In many cases aerospace firms work on a specific contract with the customer with a large extent of modifications if they do not develop complete tailor-made products and services as in the case of spacecraft or infrastructural installations. Modifications according to customer needs are prevalent even in comparatively mass-produced products like commercial aircrafts and helicopters. Nevertheless, in order to take advantage of learning curves and to mitigate high development costs which impose long-term break-even points that have major impacts on overall profitability, firms need large production runs for any kind of product. The break-even point in manufacturing is the moment at which production costs and revenue are equal. In products like commercial aircraft with large-scale development costs, the break-even point corresponds to a certain number of final products sold to cover corresponding development and ongoing production expenses starting from the first aircraft produced. It is the basis of the success of an aircraft program as companies estimate their costs based on a certain number of units produced or *program accounting*. In the past, many aircraft models and especially various European ones remained unprofitable and thus discontinued without any possibility to create a family of aircraft by their producers.

• Very long production and operational cycles – Due to its high technology content with massive amounts of knowledge input, development of a standard aerospace product may take several years. These products however, in most of the cases are capital goods for their end-users and utilized for long periods. For example, the service life of a commercial aircraft is between 25 and 30 years on average (Forsberg, 2012).

• High requirements for reliability and safety – Heavier-than-air aerospace products have to provide high degrees of safety, reliability and reactivity. Very strict requirements also necessitate high functional and safety standards that require testing and certification by national and international aviation authorities. While intensifying international relations stimulate initiatives to harmonize standards and procedures (Ecorys, 2009), certification is still a long and costly process which creates barriers for new entrants. For example, between the first flight and Chinese certification, it took more than six years for China's regional aircraft Comac ARJ21 due to multiple technical and certification problems. The aircraft has not been certified by the FAA or European EASA and until it is certified it cannot fly in the US or Europe.

• Pervasive uncertainty – different forms of uncertainty are prevalent in every stages including operational period of a product. These forms can be categorized under technological, market and competitive uncertainties. Technological uncertainty corresponds to the potential inability of the firm of developing the higher quality processes and products envisaged in its innovative investment strategy. Market uncertainty corresponds to the unknown future reductions in product prices and increases in factor prices that may lower the returns to be generated by the investments. Lastly, competitive uncertainty corresponds to the possibility that a competitor will have invested in a strategy that generates an even higher quality, lower cost product (Lazonick, 2013). In many cases technological performance of a new aircraft cannot be predicted definitively before a certain period of utilization. Besides, operating cost reductions from the perspective of customers as a sign of innovativeness depend on learning about the performance characteristics of the system and its components (Mowery and Rosenberg, 1982). Moreover, especially for commercial equipment producers, orders are inconsistent as a result of competition or business cycles and return on investment is not guaranteed (Benkard, 2000). Such a market uncertainty assumes a potential failure to access a large enough share of the market to transform high fixed costs into low unit costs and to profit from the learning curve effect. Finally, aggressive competition which also forces manufacturers to periodically upgrade models as well as to simultaneously produce several variants also creates persistent competitive uncertainty as competitors may always produce similar products in a better and cheaper way.

2.5 Industrial organization and supply chain

A remarkable aspect of aerospace industry is a complex and highly dynamic supply chain organization. Compared to early decades of the jet age when most of the work was performed in-house and both airframe and engine producers developed and manufactured their products independently (Mowery, 1988), today the industry is organized around a complex system of collaboration and subcontracting in different forms. These forms include made-to-order, multiyear contracts, technical partnerships, co-development and risk-sharing agreements. In aircraft manufacturing the system is mainly vertically structured around a lead firm or the systems integrator which coordinates the whole production process of the program beginning with initial prototype design until certification and delivery of the aircraft while it also provides after-sales services to final users. It stores all the information relative to the product and is legally responsible for the aircraft (Esposito and Passaro, 2009). Airlines are involved in the preliminary phase as consultants for the specification of the aircraft's technical characteristics and partially provide financial commitment through their preliminary orders and down payments after the launch of the program. A remarkable aspect of today's aircraft manufacturing, suppliers are increasingly involved in design and development of parts with high added-value and share the risks associated with the development of the program. Systems integrators have become more dependent upon the ability of suppliers and subcontractors to meet performance specifications and quality standards within the scope of delivery schedules.

Interconnected reasons behind the extensive supply chain development include changing technological requirements of technically superior aircraft and resulting firm specialization like higher content of electronics, software or advanced materials in newer models; new suppliers from developing economies with increasing capabilities and strong governmental support; and most importantly, corporate strategies to reorganize production processes in line with organizational and financial motives. For the very same reasons, the supply chain organization is continuously being restructured with every new aerospace program of final product manufacturers.

Thus, an important feature of aerospace industrial organization is supplier development. Supplier development can be defined as a company's undertaking to improve capabilities of its suppliers, which also involves the willingness of the supplier company to allocate resources for new physical investments and for learning new skills (Sako, 2004). Starting with subcontracting of minor parts and components manufacturing, as well as offsetting agreements with international partners, systems integrators today outsource complete sub-systems and aircraft sections to a small group of first-tier suppliers, which also organize their own supply chains in an increasingly similar manner.

However, as heavily engineered complex products, aerospace products require stringent coordination and communication in design, manufacture and operation (Sorscher, 2002) and outsourcing becomes a challenge for firms willing to externalize bigger and more complex sections of aircraft. Suppliers have to get through very large initial capital investments and extensive skills development which bring pressure to modify their business models and enlarge their scale and scope concurrently. OEMs' efforts of supplier development in their latest programs have been remarkable. They have not only provided technical expertise and knowledge transfer through contracts, but also ceded in some instances their production units and manufacturing lines to their suppliers. While outsourcing increases, a consolidation in supply chain is also being advanced partly due to concessions and price reductions OEMs ask from their suppliers (Deloitte, 2014). In the meantime, controlling costs and managing development projects have become arduous for systems integrators, reflected in escalating development costs and extended development periods with delays. Experience and tacit knowledge provide invaluable advantage over companies.

In contrast to other manufacturing sectors, low-cost supply from developing economies remain limited due to their lack of broad capabilities in aerospace. Moreover, highly automated aerospace manufacturing is another hurdle over the setting of operations in low-cost countries (PMI, 2009). Also for aerospace; the main source of competitive advantage is capabilities and mostly the organizational ones.

2.6 Workforce

The most fundamental and quite unique characteristic of employment in aerospace is the coexistence of two large armies of highly skilled blue-collar workers and highly educated white-collar professionals. The industry has a larger proportion of workers with education beyond high school than many other manufacturing industries. It is on the leading edge of technology, constantly striving to create new products and improve existing ones (BLS, 2006) while it is involved in large-scale manufacturing. Moreover, the coordination of hundreds of thousands of parts that are assembled into an aerospace product and meeting regulatory and recordkeeping requirements entail a large group of managerial and administrative support occupations. Thus the industry is both knowledge and manufacturing intensive.

Such a distinct range of workforce types is clearly visible in the statistics. Table 2.4 provides a comparison of the distribution of a selected group of occupations in the aerospace with all other manufacturing industries and US economy as a whole. The most pronounced aspect of aerospace employment which shows the distinct character of the industry within the manufacturing sector is the narrow difference between the proportions of engineering and production occupations compared to other parts of the economy. One out of six manufacturing sector engineers works for the aerospace industry. The second remarkable aspect is the higher hourly and annual wages in aerospace which are significantly above the average of all manufacturing industries. Consistent with the high level of skills and the amount of training needed, average hourly earnings of production workers in the aircraft industry are significantly above the average of all manufacturing industries. The average annual wage in the sector is around 50 percent higher than the average manufacturing wage. Such highlights are quite similar for aerospace industries in other parts of the world. OECD Structural Analysis Database provides similar correlations between aerospace employment and higher wages in Europe (OECD STAN, 2012).

Table 2.4: US Industry-Specific Occupational Employment and Wage Estimates in May 2013

Sector	Occupation title	Workforce	% of total workforce of the sector	Mean hourly wage	Annual mean wage
NAICS 336400 - Aerospace Product and Parts Manufacturing	Engineers	87,810	17.47	$46.13	$95,950
NAICS 336400 - Aerospace Product and Parts Manufacturing	Architecture and Engineering Occupations	109,250	21.73	$43.36	$90,180
NAICS 336400 - Aerospace Product and Parts Manufacturing	Production Occupations	166,300	33.08	$23.31	$48,490
NAICS 336400 - Aerospace Product and Parts Manufacturing	All Occupations	**502,740**	**100.00**	**$34.65**	**$72,070**
Sectors 31, 32, and 33 – Manufacturing	Engineers	557,090	4.65	$42.71	$88,830
Sectors 31, 32, and 33 – Manufacturing	Architecture and Engineering Occupations	777,790	6.49	$38.08	$79,200
Sectors 31, 32, and 33 – Manufacturing	Production Occupations	6,163,470	51.43	$17.11	$35,590
Sectors 31, 32, and 33 – Manufacturing	All Occupations	**11,983,290**	**100.00**	**$23.00**	**$47,830**
Cross-industry, private, federal, state, and local	Engineers	1,547,580	1.17	$44.31	$92,170
Cross-industry, private, federal, state, and local	Architecture and Engineering Occupations	2,380,840	1.80	$38.51	$80,100
Cross-industry, private, federal, state, and local	Production Occupations	8,765,180	6.61	$16.79	$34,930
Cross-industry, private, federal, state, and local	All Occupations	**132,588,810**	**100.00**	**$22.33**	**$46,440**

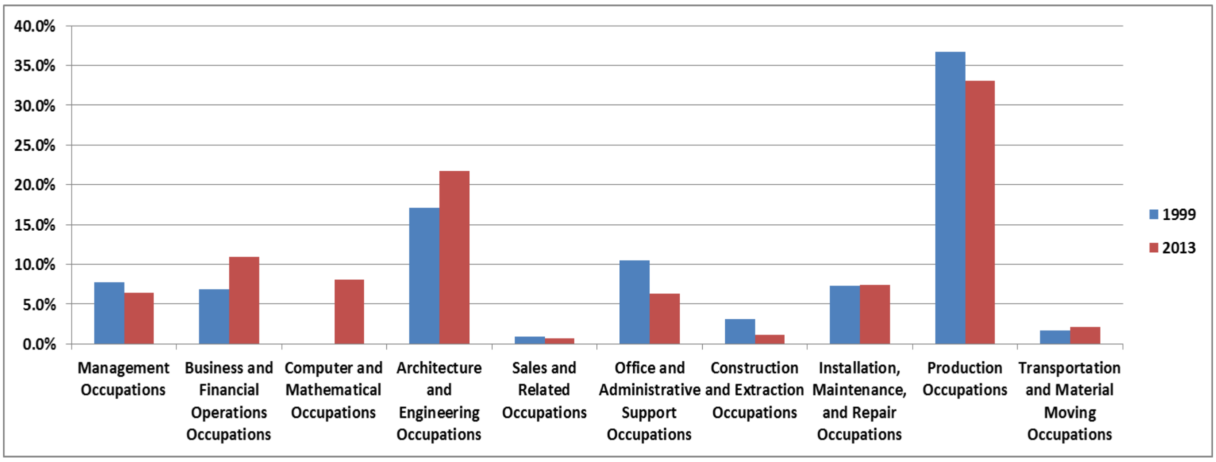
Source: Bureau of Labor Statistics of Occupational Employment

A main feature of Western aerospace employment is its rapid decrease at the end of the Cold War mainly due to sharp fall in defense budgets in the early 1990s. After this steep fall aerospace employment has been stabilized in Europe and the US, in contrast with the continuous decline in manufacturing employment in these regions (Figure A.5 in Appendix).

Another marked feature is the decline in the proportion of production workers to total aerospace employment. Figure 2.9 shows the change in the composition of the US aerospace workforce between 1999 and 2013. While total employment in aerospace is almost unchanged (502,270 in 1999 vs. 502,740 in 2013) in BLS statistics, the composition has considerably changed. The decrease in production, construction and support occupations is compensated with more engineering, financial and computer related occupations. The reason for the limited decrease in production occupations may be the high-tech character of aerospace manufacturing that is still concentrated in developed economies. Western OEMs have only started in the last decade to outsource or offshore considerable work to developing economies which explains the stability of aerospace manufacturing compared to the free fall of manufacturing as a whole in Western economies. The proportional rise in engineering occupations is related to the increase in technological complexity and the massive integration of advanced systems into final products. The production process has also become much more automatized with advanced machinery and tooling. The last but not least, increasing outsourcing has put forward the role of specific professions like industrial engineering through the rising needs of operations management and systems engineering. Inspired from car manufacturing industry, the motivation to develop faster, better quality and lower cost products also led aerospace firms to utilize new management techniques like lean manufacturing which presumes low inventory levels with high levels of subcontracting.

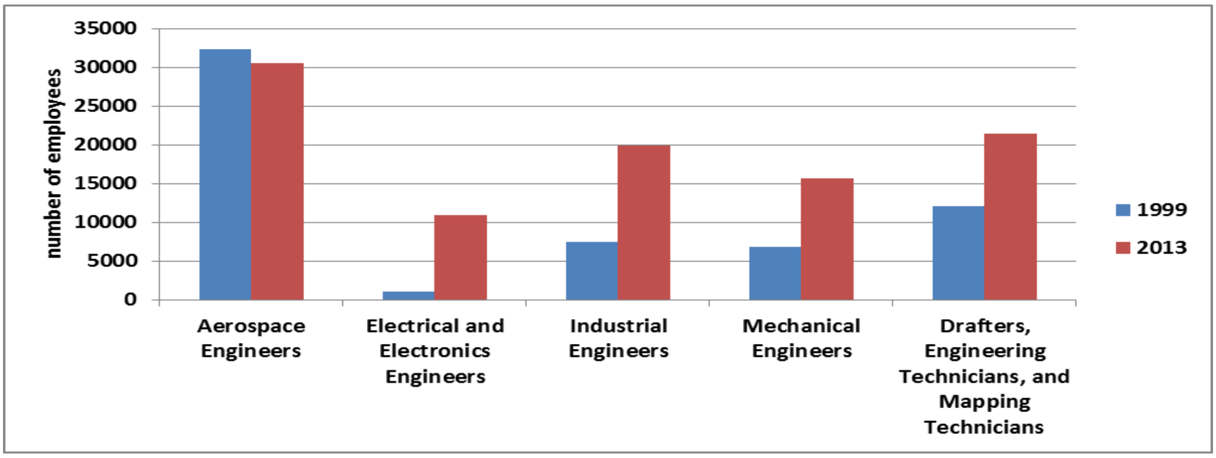
Figure 2.10 shows the changing structure in the employment of engineers in US aerospace. The total number of engineers has increased from approximately 86,000 to 109,000 between 1999 and 2013. The main source of the overall increase comes from the rise in the employment of electronic, industrial and mechanical engineers while the number of aerospace engineers actually decreased. Demand for highly-skilled workforce with up-to-date knowledge in advanced technologies has long been a hot topic among industry representatives and policy makers (AIA, 2008; INSEE, 2010).

Figure 2.9: The comparison of the composition of US aerospace workforce in 1999 and 2013



Source: BLS Occupational Employment Statistics

Figure 2.10: The comparison of the composition of aerospace engineering workforce in 1999, 2013



Source: BLS Occupational Employment Statistics

Learning processes and retaining skills are also important to cope with shortcomings like costly rework, repair and to avoid bottlenecks and other interruptions in production. As an example, for Boeing 787, Boeing workers in Seattle and San Antonio worked hard on reworking parts with defects delivered by suppliers and refurbishment of early aircrafts produced by company's inexperienced North Charleston employees. Maintaining enough qualified employees is one of the industry's chief challenges (Kronemer and Henneberger, 1993). The high productivity of aerospace depends on skills retention, employment and career opportunities (Lynn, 1995).

2.7 Finance of the Industry

The aerospace industry has both similar and distinct characteristics with other higher R&D spending manufacturing sectors in term of corporate finance. Uncertainty is prevalent in every stage of the innovation process as well as during the period after any product launch. Supplier involvement in product development and production increasingly includes financial participation in the success or failure of the project that entails suppliers to share financial risks involved in projects. As in other manufacturing sectors, the major issue of smaller suppliers and other small subcontractors is the difficulty in accessing finance which aggravates with any delay of the program and related financial pressures (INSEE, 2010).

Financial risks are also shared by the airlines as long as they are involved in product development by providing commitment with upfront payments. Airlines usually buy new aircraft under long-term contracts which specify delivery dates. These contracts include upfront, progress and final payments while the biggest amount is paid when the aircraft is received. If the aircraft manufacturer does not meet the prescribed delivery date, it faces a penalty. Moreover, aircraft manufacturers do not recognize any revenues until the aircraft is delivered. Thus the long-term contracts primarily benefit the buyer and they put seller under pressure especially if the contracts are about a new aircraft program where the probability of a delay is much higher (Tortoriello, 2010).

Tightly connected to the large set of uncertainties, estimates are fundamentally important in commercial aircraft manufacturing. Such estimates crucially differ from the other segments of the industry like defense or space programs where the amount of the order is tightly estimated and total sales are based on negotiated contract prices and quantities. In civil segments, changes in underlying estimates, supplier performance, or airline industry performance circumstances directly affect the financial performance of manufacturers.

Another feature of commercial segments of aerospace is customer financing. Manufacturers also provide financing for their own products to customers as an alternative or complement of other financing mechanisms like commercial bank loans or export/import bank financing.

While manufacturers commit large amounts of their own resources in new product development and following improvements, government support is still the single most important source of innovation finance in aerospace industry which deserves a detailed discussion presented below.

2.8 Government Presence

> *"Without federal government [support] there would simply be no aircraft industry despite the fact that the commercial market is playing a much larger role than it has in the past*".
> (Bluestone, Jordan and Sullivan, 1981, p. 170, excerpted from Ruttan, 2006, p. 65)

Diverging destiny of the aerospace industry from the rest of the manufacturing sector in the West is a primary incentive to analyze the extent of the role of government support to the industry.

Adopting the idea that markets and international trade are outcomes of industrial development rather than a cause of it and the roots of industrial development nourished primarily from innovation, skills, and technological development; the role of government emerges as a fact more than a proposal. In effect, the role of government goes beyond the funding of basic or applied research and it also includes mobilizing resources and allowing knowledge and innovations to diffuse across the economy (Mazzucato, 2011) and it is the government investments in knowledge base that give the meaning of the term developmental state (Lazonick, 2012). To explain the dominance of a specific economy on a particular technology or industry, a view on the role of government is an integral part of any business history research.

The aerospace industry is a genuine example to account the role of developmental states and their institutions in supporting innovative firms since the era of Wright Brothers' monoplanes, until today's all-composite jet airliners. A quick explanation of the role of governments can be given through massive government military investment both in the forms of manufacturing contracts and military or civilian research and development aid that also provided the aerospace industry with substantial incentives to bring affordable products to the civilian market (Mowery and Rosenberg, 1982). The strong ties with defense industry and still prevalent military-civilian interaction in aerospace research and development are basic factors that explain the strategic importance of the industry. It may also help to explain in part the persistence of the aerospace industry as one of the leading manufacturing industries in terms of employment and sales and export revenues in developed economies. However, the role of government in promoting innovation and technological development extends beyond R&D support, procurement and other forms of assistance that help firms to achieve the benefits of generating and adopting new technologies. In effect, such a strategic character is the result of a combination of the size of its direct contribution to the economy (employment, taxes, domestic and international sales) and the extent of its technological and industrial base within an economy and a skilled and qualified labor force it maintains. An analysis of government support to the aerospace industry has to look from a developmental-state perspective that does not solely focus on the role of government in fostering technological development but also explains the development and maintaining of knowledge base as the fundamental source of the wealth of a nation that cannot be restricted only to financial success.

Nevertheless, the power of government in determining the structure of the industry is not a unidirectional process. The source of innovation and economic growth in a capitalist world is principally based on the decisions taken by innovative enterprises. Thus, there is a complementarity between the developmental state and innovative enterprise in generating economic growth (Lazonick, 2012). It is this complementarity that provides motivation to go beyond the R&D support role and deepen the discussion of the role of governments in industrial development that also gives the opportunity to see conflicts that may also happen between the objectives of these two actors of economic life. A broader research framework is needed which combines a discussion on the role of government in fostering economic development to an analysis of innovative enterprise that *a priori* creates value and shares it with every contributing stakeholder.

To identify the motives behind government support to aerospace industry from a historical perspective, it is necessary to explain the reasons and mechanisms of support and detail them in the context of the US and EU whether they are specific to Airbus and Boeing or they concern wider industrial community. In the case of a US-EU comparison, it is also crucial to document the decades long trade dispute between the two sides of Atlantic and its outcomes while putting it in a context that not only helps to explain specific mechanisms of support to Airbus and Boeing, but also to show the distinctive elements of the institutional settings in US and

European contexts. Such a distinction may also provide insights to explain different ways of functioning of these two firms.

2.8.1 The role of government in aerospace, why and how?

The reasons that explain the strong government support in the aerospace industry center on two interrelated factors, both of which consider the role of innovation, economic growth and established industrial characteristics that can be summarized in the combination of a high level of producer concentration with fierce price and quality competition (Mowery and Rosenberg, 1982), long lead times, high economic and industrial value of aerospace projects and their long term consequences for national economies (Hayward, 1975). The first factor focuses on the strategic character of the industry, especially considering its military content. National security considerations explain a majority of aerospace expenditures channeled to support military aerospace, which has had a significant impact on technological innovation in commercial aircraft (Mowery and Rosenberg, 1989). Moreover, government support to the aerospace industry is a precondition to act as a strong state that is capable of realizing its commitments to the domestic and international economies (Francis and Pevzner, 2006). For example, in the case of France, the leading country in the formation of Airbus consortium as a Pan-European project, its ambition to support Airbus - and many other aerospace development programs in Western Europe in the period after the Second World War - was an explicit sign of challenging American hegemony in civil aerospace (Thornton, 1995). The second factor is the simple justification that government subsidies were either initiated or expanded in order to support domestic industries against much stronger rivals; for example, the dominant US aerospace against staggering European aerospace in the after-war period. Government support in different forms is necessary to nurture an infant industry against strong competitors that dominate the sector (Carbaugh and Olienyk, 2004) and to develop an R&D and manufacturing infrastructure and a pool of skilled labor that enable domestic firms to undertake ventures without bearing the full cost of development (Carbaugh and Olienyk, 2001).

The US and European government support in aerospace is a well-documented case not solely because of the strategic role the industry played along the twentieth century as an integral element of defense and armament or other strategic reasons maintained through different institutional and organizational settings. The conflict between the US and European Community around government subsidies that started in the 1980s also provided a rich documentation of specific programs and support mechanisms. Thus the discussion can be divided into two periods. The first period starts from the very early days of aviation until early 1980s when the trade dispute between the US and European companies and their respective governments started.

2.8.2 From early years to 1980s – The rise of aviation and changing leadership

In this first period, the extent of government support to aerospace industry was no less deep and diversified than today but the intervention was much more visible on both sides of the Atlantic mostly due to the disproportionate weight of military aircraft production. While the early period of aircraft production is marked by 'dedicated enthusiasts', they were still expecting a return on their investment as Rae (1965) puts:

> *"It became manifest early that governments, in particular the military services, offered a more promising source of revenue than stunt flying at county fairs".*

Europeans were the pioneers of investors in aviation and between 1908 and 1913 major European governments (excluding Russia) spent more than $70 million on aviation while the US spending was less than $400,000 during the same period (Ruttan, 2006). In some cases, US firms started to do business in Europe before they sold their airplanes to the US government (Rae, 1965). The US industry gathered its strength only during the First World War to fulfil military needs. In four years, the industry was transformed from a craft-oriented workshop operation into a manufacturing process geared to mass production (Todd and Simpson, 1986). During the war, a total of more than 150,000 airplanes were produced by British, French and German manufacturers while the number was close to 13,000 airplanes for the US during the 18-month period between the time it entered the war and the end of the war (Ruttan, 2006; Todd and Simpson, 1986).

However, the momentum that had developed during the war abruptly ended with the cessation of hostilities. Governments immediately cancelled their existing orders, and since commercial markets for airplanes had not yet been established to compensate, the result was an industrial collapse (O'Sullivan, 2007). In effect, while the military expenditure on aeronautics had almost vanished, commercial air transport was only coming into the world.

Remaining actors in the industry concentrated their efforts on advanced commercial aircraft models, and they helped to mark the 1920s as a period of significant technological change. The performance of different countries was not the same, and government action or inaction was critical.

In the US, government action was through two channels. The first was regulation and related subsidies in airline development. For the main US players of the period, to become major actors in the creation of a commercial aircraft industry was not probable if they had to rely on their own private financial resources to develop new technologies in anticipation of an eventual demand. Also in the 1920s, it required huge capital expenditures on organization and technology to generate the possibility of providing passengers with high-quality, affordable air services and it was the US government's explicit effort to build the nation's communications infrastructure that led to the rapid growth of air transport and commercial aircraft industry. In the rapid evolution of the demand for new planes, the leading role was of the US Post Office. The two acts on mail transport authorized in 1925 and 1930 provided subsidies to carriers to develop airmail services that increased aircraft demand and incentives to order larger aircraft from manufacturers as they were getting more capable of providing passenger transport. The establishment of Civil Aeronautics Authority in 1938 contributed to the further success of US aerospace in the postwar years by creating strong incentives for rapid adoption of innovations (Mowery and Rosenberg, 1989). Major US aircraft companies provided various models of high quality aircraft by virtue of their innovative activities as well as the latest aircraft technology developed beyond their in-house efforts (Ferleger and Lazonick, 1994). Leaning on their products' superior technology, US manufacturers also campaigned for foreign business and established a dominant market for US-built aircraft (Rae, 1965).

The second channel of government action that fostered the development and growth of US commercial aircraft industry was the direct support of research through industry-friendly tailored institutional settings, crystallized with the support and conduct of the government organization National Advisory Committee for Aeronautics (NACA) established as early as 1915 shortly before the US entry into the First World War. Prior to 1940, or before the jet era started, NACA functioned primarily to provide research infrastructure in the form of experimental design data and testing facilities, such as wind tunnels which was very critical considering the limited sources for research and limited capacity of the industry. The research either supported or conducted by NACA was not only confined to military domain. The steady flow of research coming through NACA facilities led to major improvements in airframe and engine design and efficiency (Mowery and Rosenberg, 1989). One important aspect, it was NACA who defined the rules of providing incentives for applied research on generic technological innovations which is much more accessible to the industry as a whole compared to proprietary research. These incentives have worked in the same manner up until to the present in the US context.

In Europe, the performance of national aircraft industries was not analogous during the period between the two world wars. In Britain and France, military aircraft demand was very limited until rearmament schemes commenced in mid-30s (Chapman, 1991; Todd and Simpson, 1986). In the case of France, up until the generous subsidies to airlines initiated in the first half of the 1930s and the nationalizations in the second half, the industry was suffering from lack of demand by airlines, the early neglect of the state to support new designs and technology development, and fragmented and uncompetitive industry structure (Chapman, 1991). However, it was already time for the reorganization of production due to rearmament launched in 1937, and privately-held firms were also part of the military campaign either in the form of airframe builders of subcontractors (Chapman, 1991).

After an enormous campaign of aircraft production serving only for military purposes expanded and transformed widely towards military needs during the Second World War, the industry went into a drastic retreat with the end of the hostilities once again. However, the large-scale research efforts led especially by Germany and Britain during the war left a substantial technological repertory that opened a new technological paradigm marked by jet propulsion, swept-back wings, and advanced metals technologies.

In the US, the new era started with a design revolution owing to the advances in technology introduced primarily by Europeans (Ruttan, 2006). Different than the period after the First World War when military spending was sharply cut (Rae, 1965); the US military was prompt to fund a new line of military aircraft, utilizing newest technologies including the swept-wing. The industry was also concerned to develop a commercial aircraft utilizing same technologies in the wake of rising British jetliner industry. Main representatives of the industry pushed

Congress to pass a bill to provide government funding for a commercial aircraft, but the industry failed to unite behind the bill and the measure was cancelled (Lynn, 1995). However, Boeing was advancing its focus on jet technology. It had first-hand access to German aerodynamic research results and designs, after it signed contracts with US Air Force for different models of military aircraft. It also participated in the Air Force contest for a military jet refueling tanker with its prototype which had been designed before the contest and it was successful to win. Rapidly escalated profits during the military campaign of the Korean War helped Boeing to advance its efforts to develop a commercial aircraft version of the military jet tanker together with the Independent Research and Development funding provided by the Air Force to be used in prototype design and development. At the time, 82 percent of the profits earned had to be returned to government in the form of corporate tax if they were not spending on new aircraft development. This was also an important incentive for Boeing to further its development efforts. Even more, after negotiations with the Air Force, Boeing gained access to tooling and plant space used for the jet tanker (Rodgers, 1996). Strongly endorsed by mechanisms of government support, the audacity of Boeing to launch the commercial version named as B707 worked and the aircraft, which set the standard for modern commercial aircraft design to date, turned into a commercial success and the company initiated another development program before the end of the 1950s. Douglas which was active in the commercial aircraft business with a continuous decline of market share until it was acquired by Boeing in 1997 and Lockheed which left the business in 1981 after unsuccessful product launches only played the second and third fiddles during the jet era. In effect, federal loan guarantees were ready to help the merger of McDonnell and Douglas Aircraft which rescued Douglas from bankruptcy in 1967, and to prevent the collapse of Lockheed in 1971. The federal government, in essence was directly involved in determining the structure of the industry in the 1960s and 1970s (Mowery and Rosenberg, 1982). However, in the international level, US commercial aircraft industry was simply a great success story. By 1980, sales by US producers captured more than 90 percent of world commercial aircraft market except East Bloc (Baldwin and Krugman, 1988).

If military procurement contracts kept commercial aircraft producers financially afloat to take more risks to develop new aircraft models, another major source of innovation was the research and technology support of the US federal government through The National

Aeronautics and Space Administration (NASA) and The Department of Defense (DoD) technology programs and research contracts.

The successor of NACA with a broader horizon beyond supporting basic research, NASA was founded in 1958 with the main objective of preserving of US leadership in aeronautical technology, specified in its charter. During the postwar period, besides its research infrastructure in the form of test facilities and qualified personnel, NASA provided commercial aircraft industry long-range technology transfer through generic or focused research programs and technology demonstrations to assess the feasibility of real components, systems or platforms (Lawrence, 2001).

Besides its fundamental role of funding military aircraft development, DoD also provided research funds for dual-use initiatives to promote the development of commercial technologies and improvements in production efficiency. Various innovations in fields like materials, avionics and also some manufacturing technologies were derived from military programs by commercial aircraft producers (Lawrence, 2001).

According to one estimate of the cumulative investment in R&D in aeronautics from 1945 through 1982, 83 percent came from federal sources; of which 90 percent was military R&D. Industry-financed R&D was only 17 percent of the total and its basic research accounted less than 1 percent of total aircraft R&D during this period (Mowery and Rosenberg, 1989).

While the commercial aircraft manufacturing emerged as a distinct segment of the aerospace industry in the US, the future was gloomy in Europe even though it was Britain, a European country which introduced the first but unsuccessful civilian jet aircraft Comet in early 1950s, earlier than any US company. In Europe, early post-war efforts to regenerate aircraft production once again focused on the military side, and thus governments were the main decision makers of resource allocation and product choice. Rejuvenating commercial manufacturing was not on top of the agenda. Limited financial resources were generally directed to military procurement and related research and development support. More than that, organizational difficulties were hindering a rapid growth.

In the postwar period, European aerospace industry was highly fragmented even within national borders all around the continent. Not so irrational for the time, this fragmented structure was even stimulated by governments. In Britain, France and Germany, common features of the industry policy were to encourage design, technical standardization and specialization with a relatively large number of selected firms. The second feature of organizational structure was the attempt to maintain collaborative aircraft programs especially on the military side. Having lack of sufficient financial strength and technological capabilities as well as markets big enough to absorb enough capacity, European governments launched several military programs not always provided satisfying results for the partners (Thornton, 1995). It was, however, an experimentation for the future civilian undertakings of collaboration. In the meantime, a series of industry consolidation within national economies was in the course. The governments had a prominent role in these efforts, not so unusual for the case that these companies also had military contracts or they were subcontractors of various running programs.

The first attempt of European cooperation in civil aerospace was the Concorde. The project was launched after a strict binding agreement between British and French governments. While political considerations dominated the project's difficult technical, administrative and financial aspects, governments failed to insure participating firms to have incentives to control costs (Thornton, 1995). The hesitation of national and international customers to invest in such a costly capital good put an end to one of the most audacious technological and industrial projects in the world to date. Lessons learned about technology and organization, both negative and positive, were, however, of great value for the next collaborative effort, namely Airbus.

The limited success of some national efforts in civilian aircraft production in the 1960s, like French Caravelle or British BAC-111, were not sufficient for Europeans to keep even a modest share of the global market against big advances by the US companies during the same period. Both European politicians and industrialists were highly concerned with the erosion or simply underdevelopment of Europe's competitiveness in the aerospace industry, and collaborative efforts were more important than ever to provide an answer to the US dominance considering the still inadequate scale of national resources and markets. After intense government-level negotiations, Airbus Industrie was established as a *Groupement d'Intérêt Economique* (GIE) under French law in 1970 by French and German shareholders Aerospatiale and Deutsche Airbus. The British government withdrew from the negotiations and only a private British company joined Airbus as a business partner. Already configured by partners before the formation of GIE, A300, the first Airbus aircraft, was financed completely through government funding in the form of repayable loans that were to be repaid only if the program was successful. Whether the current Airbus organization of product development is substantially different, beginning with A300, for all of its development programs, Airbus used such funding with similar liabilities up until today.

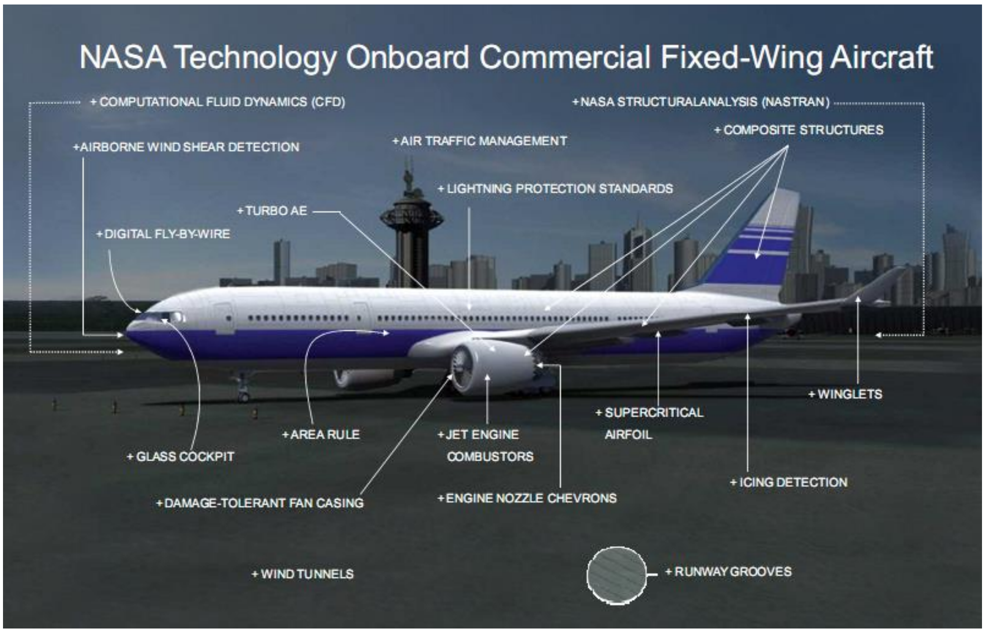
2.8.3 Since mid-1980s – World-level consolidation and decades long dispute

In September 1985, several days after Boeing had lost a bid against Airbus to sell a number of aircraft to India while Airbus had successfully been making inroads into Boeing's other markets including the US domestic market, US president Reagan gave a 'much-publicized' speech on trade policy and mentioned several alleged violations of trade agreements by US trade partners including Airbus (Tyson and Chin, 1993). Meanwhile, Boeing openly accused European governments of subsidizing Airbus and urged the US government to start negotiations over subsidies with Europe. In effect, the commercial aircraft industry had already been part of the trade negotiations between the United States and Europe, and the General Agreement on Tariffs and Trade treaty signed in 1979 had included a separate section on commercial aviation. This section, the Agreement on Trade in Civil Aircraft, abolished customs duties on aircraft and components and instituted multilateral controls on government procurement and public subsidies both for the development and the sale of aircraft (Mowery and Rosenberg, 1989). Despite the agreement, during the second half of 1980s, the US and European authorities continuously blamed each other for receiving illegal subsidies while they were holding official talks to reach a solution.

Another development that has had implications for the industry in the long term was the deregulation of US airlines in 1978 which liberated US carriers by allowing them to decide which route they could fly at what cost to the passenger (Newhouse, 2007). The effect was increasing competition that created a cost pressure on airliners and thus a weakening demand for new aircraft that could not offer substantial cost reductions (Ruttan, 2006). In Europe, the deregulation was gradual. It was initiated in the second half of 1980s and completed only in the 1990s (Kawagoe, 2008). Aircraft producers were under great pressure to offer more efficient products with lower risk sharing with customers. In that sense, the US and European aircraft producers were highly active in the 1980s in new product development. During the decade a total of 10 new commercial aircraft programs were either launched or put into service by Boeing, Airbus and MacDonnell Douglas (for a comparison, this number was only three in 2000s; A380, Boeing 787 and A350).

From the early 1980s, despite the escalation of the anti-subsidy rhetoric in the US (Lawrence, 2001), the rising competition stimulated by European efforts to elevate Airbus as a global player, and the US government's concern with the US competitive position in the international commercial aircraft industry, led to a continuous increase in the allocation of government funds directed to commercial aircraft technology development especially through NASA and DoD. By the early 1990s, NASA and the Air Force were engaged in R&D in almost every dimension of aircraft technology (see Figure 2.11 as an example) and were devoting substantial resources to large commercial aircraft research (Ruttan, 2006). During the 1990s, a budget of more than $1 billion each year were devoted to generic or commercial aircraft research by NASA and the Department of Defense (Lawrence, 2001). Airbus has also been a beneficiary of the support funded by the US federal government either through open access to NASA research results as long as it is publicly available or through indirect help in the form of inputs with superior technology provided by NASA-funded US equipment and parts suppliers (for the role of NASA funding for aerospace suppliers see Sherry and Sarsfield, 2002).

Figure 2.11: Application of NASA funded research on commercial aircraft



Source: Shin, 2011

The rise of Airbus to become a global player was by far the most important development in commercial aircraft industry during the 1980s and 1990s. Its market share increased significantly at the expense of US manufacturers and especially McDonnell Douglas and Lockheed, and in only 11 years between 1981 and 1991, the company initiated the development of three different models of aircraft (A320 in 1981 and A330/A340 in 1986) and launched a market demand research for a super jumbo. These efforts in effect were only possible through generous subsidies provided by European governments. Launch aids provided for these three programs covered a substantial part of development expenditures. The 1992 Agreement put a ceiling to government support that it cannot exceed 33 percent of total development costs, and the rule was applied to A380 and A350. Recurring deficits of Airbus partners in the 1990s put an emphasis on the role of government support in the commercial segment of the aerospace industry in Europe. A fragmented industry hit by big cuts in military spending would not have been capable of sustaining such a successful commercial investment effort.

Thus, there is a strong correlation between the strengthening competition, rapidly escalating product development costs and demand for deepened government support to the aerospace industry. Rising financial risks or hesitations of firms to launch costly R&D programs render government support even more critical to initiate such high-cost programs. The result for the commercial aircraft industry was the intensification of the trade dispute between the US and European countries. In 1990, the US Department of Commerce assigned a research company, Gellman Research Associates, to prepare a study on the economics of Airbus' aircraft programs and after an examination of the support provided to Airbus Industrie and its partner companies for each development program, the study concluded that Airbus would not have been commercially viable or it would not have existed from the very beginning without substantial government support (GRA, 1990). Obliged to provide a response, in 1991, the European Commission hired Arnold and Porter, a US law firm, to prepare a report on US government support of its commercial aircraft industry. Drawing attention to the lack of transparency in the data available to measure the extent of support as the Gellman study also did, the EC report identified specific means of support and introduced the indirect support concept that US industry benefited extensively through its access to multiple forms of R&D and manufacturing support and specific provisions for civil aircraft programs (Arnold and

Porter, 1991). The US study reported a $25.8 billion subsidy in 1990 prices for the period between 1968 and 1990, while the EC report provided an estimated benefit for the US industry of between $33.5 billion and $41.5 billion for the period between 1976 and 1991 in 1991 prices. While the calculations of the US and EC reports of the total amount of support for European and US civil aircraft industry were bewildering for the general public, the clash of studies on government subsidies implied a compromise between the two sides rather than a major trade conflict (Carbaugh and Olienyk, 2001; Lawrence, 2001; Thornton, 1995). In July 1992, the EC and the US signed the agreement on the application of the GATT agreement on trade in civil aircraft. The deal clarified the forms of government support by separating indirect and direct support and set certain limits to existing subsidies as an admittance of the existence of a variety of support and their depth[5]. After the GATT Uruguay Round and its replacement with WTO effective with 1995; 1992 rules related to subsidies that are applied to large civil aircraft were aligned with WTO rules.

While the 1992 Agreement seemed to serve its purpose to some extent in decreasing the tension between the parties in the 1990s, Airbus' launch of A380 which ended the US monopoly in the 400+ seat segment after partnering governments of Airbus committed their support to its development put an end to already the fragile compromise. The US argued that the A380 subsidy could be illegal under WTO rules as Airbus did not have any financial liability to the European governments (Pavcnik, 2002). Over the issue, the US filed a request to WTO for consultations to resolve the dispute in 2004; however, the US ended the consultations and withdrew from the 1992 agreement.

It may be asked why the US did not withdraw from the agreement and then initiate the negotiations for a new bilateral agreement right after the official launch of the A380 program in 2000, but waited around four years to restart the dispute. The original US Trade Representative document answers this question in such a way: "For its own business reasons, however, Boeing did not support such a course"[6]. However, the reasons are important to

[5] The agreement set a limit of direct government support on aircraft development to 33 percent of program costs that is subject to full repayment on a royalty basis. Indirect supports should not exceed 3 percent of a nation's total large civil aircraft industry's annual turnover, or 4 percent of the annual turnover of any single aircraft manufacturer in that nation. In contrast to the system of direct government support on aircraft development, there was no requirement for reimbursement of indirect support.
[6] "U.S. Files WTO Case Against EU Over Unfair Airbus Subsidies", Office of The United States Trade Representative, Press Release, October 6, 2004

reveal in order to understand the mutual character of the subsidy dispute that while one party attacks its rival, it has to position itself in such a way that its subsidies could either be disguised or excluded from the dispute. Boeing adopted a proactive approach and withdrew from the 1992 Agreement while it was setting agreements with several US states regarding state-level subsidies and signing 787 workshare agreements with international partners like Italy or Japan manufacturers that are strongly supported by their respective governments. Especially the proposed support of Japanese government for the 787 program would initiate a WTO dispute not only because the support might be prohibited due to its export contingent nature, but also because a strong motivation of the Japanese aerospace industry to develop its indigenous capabilities in order to launch domestic programs (Pritchard and MacPherson, 2004). Quite expectedly after the appeal of Airbus to its respective governments for another round of direct government support for its new program A350 in early 2005, Boeing also filed a WTO suit against Airbus claiming that Airbus received illegal subsidies since its establishment. Airbus' response was another suit filed the following day against Boeing similarly claiming that the federal and state subsidies for Boeing were illegal. In the meantime, both companies and their national and international allies kept reporting their rival's unfair subsidies and their negative impact on competition (Boeing, 2009; Center for Security Policy, 2010; EADS, 2010; EC, 2007).

After a long period of evaluation and appeal procedure, in 2010 and 2011, WTO clarified that both Airbus and Boeing received substantial amounts of subsidies since the late 1980s and some of these subsidies were actually illegal according to WTO rules (WTO, 2010, 2011a). Without rejecting the idea that they received subsidies, each company claimed victory over the other[7]. Each company argued that the illegal subsidies received by one company distorted trade to the detriment of the other. The WTO Appellate Body reports published one year after the panel reports for each case rejected the biggest part of both companies' appeals of the WTO's earlier findings and confirmed that Airbus and Boeing received illegal subsidies during the period investigated (WTO, 2011b, 2012).

Table 2.5 provides a list of subsidies received by Boeing and Airbus. The first group of subsidies (A) in each table is the subject of the WTO cases filed against each company. The second group (B) is brought together after an inquiry of government support mechanisms for the aerospace

[7] "Boeing Calls WTO Ruling a Landmark Decision and Sweeping Legal Victory", Boeing Press Release, June 30, 2010; "WTO final ruling: Decisive victory for Europe", Airbus Press Release, May 18, 2011

industry in general or for the company in question. The inquiry remains incomplete, and it can be developed further with continuing government support to commercial aircraft manufacturing on both sides of the Atlantic.

Table 2.5a: Subsidies given to Airbus

Subsidy source	Subsidy details	Period	Sponsor authority	Approximate amount of funding with current prices	Approximate amount of repayment if available
A. Subsidies identified by WTO case as 'specific' to Airbus					
Launch Aid (term used by the US)/Member State Financing (term used by the EU)	Finance of the development costs close to 100 percent for the early projects (A300 and A310) Finance a maximum of 33 percent of development costs for after the entry into force of the 1992 Agreement (specific versions of A330/A340 and A380)	1969-2006	national	~$15 billion	unknown
Loans from European Investment Bank (EIB) (a total of 12 loans)	Loans provided to British Aerospace (A320 and A330/A340); Aérospatiale (Super Transporteurs and A330/340); Construcciones Aeronauticas SA (A320 and A330/340); Airbus Industrie (A321); and EADS (A380)	1988-2002	international	~$1.2 billion	~$1.2 billion
Infrastructure and infrastructure-related grants	Grants or direct investments in industrial sites, road and airport improvements by German, French, British and Spanish national and regional governments and local authorities	2000-2006	national regional/state local	unknown	0
Research and Technological Development Funding	Grants and loans for R&TD undertaken by Airbus (including framework programmes)	1986-2006	international national regional/state	unknown	unknown
German and French restructuring measures: Debt forgiveness	The forgiveness by the German Government of debt owned by Deutsche Airbus	1998	national	unknown	0
German and French restructuring measures: Equity infusions	Capital investments made by the French Government	1987-1998	national	unknown	0
B. Subsidies that are not subject to WTO dispute either because they are out of the scope of dispute or out of the time scope of the case					
1) Other benefits not specific to aerospace industry but received by Airbus					
Tax credit for R&D expenses	Income tax credits granted to Airbus for research and development activities that are deducted from corresponding expenses or from capitalized amounts when earned.	2000-2014	national	€795 million	0
Interest free loan	An interest free loan was granted by Lagardère and the French State to Airbus in 2007 (The amount of € 29 million was repaid in 2011)	2007	national	€29 million	€29 million
State of Alabama	An incentive package of $158.5 million supporting the construction of the plant, improving roads, regarding soil	2015	regional/state local	$158.5 million	0
2) Other benefits specific to aerospace and airlines industries (Airbus may also be a direct or indirect beneficiary)					

EC Framework Programmes	Grants directed to civil aeronautics research	1987-2013	international	€3.7 billion	
French Directorate General for Civil Aviation	Grants and repayable advances for civil aviation projects	annual	national	unknown	
Export Financing	German, French and British export credit support provided to aircraft buyers	1975-	national	unknown	-
Export Financing	European Investment Bank financing provided to aircraft buyers	1990-	international	unknown	-

Table 2.5b: Subsidies given to Boeing

Subsidy source	Subsidy details	Period	Sponsor authority	Approximate amount of funding with current prices	Approximate amount of repayment if available
A. Subsidies identified by WTO case as 'specific' to Boeing					
The provision of tax incentives by the State of Washington and municipalities therein	- Business and Occupation tax reduction; - B&O tax credits for preproduction development, computer software and hardware and property taxes; - Sales and use tax exemptions for computer hardware, peripherals and software; - City of Everett B&O tax reduction; - Workforce development program and employment resource center	1989-2006	regional/state local	$77.7 million (future benefits are not included)	0
State of Kansas and Municipalities therein	Property and sales tax abatements provided to Boeing pursuant to Industrial Revenue Bonds issued by the State of Kansas and municipalities therein	1989-2006	regional/state local	$476 million	0
State of Illinois and Municipalities therein	- Reimbursement of a portion of Boeing's relocation expenses provided for in the Corporate Headquarters Relocation Act ("CHRA"); - 15-year Economic Development for a Growing Economy ("EDGE") tax credits provided for in the CHRA; - Abatement or refund of a portion of Boeing's property taxes provided for in the CHRA; - Payment to retire the lease of the previous tenant of Boeing's new headquarters building	2002-2006	regional/state local	$11 million	0
NASA	- The payments made to Boeing pursuant to procurement contracts entered into under the eight aeronautics R&D programs; - Access to government facilities, equipment and employees provided to Boeing pursuant to procurement contracts and Space Act Agreements entered into under the aeronautics R&D programs	1989-2006	national	$2.6 billion	0
Department of Defense	-The payments made to Boeing pursuant to assistance instruments entered into under the RDT&E Program; - Access to government facilities provided to Boeing pursuant to assistance instruments entered into under the RDT&E Program	1991-2006	national	unknown (but equal to or greater than $308 million)	0

US government Foreign Sales Corporation/ Extraterritorial Income export support	-The tax exemptions and tax exclusions provided to Boeing under FSC/ETI legislation, including the transition and grandfather provisions of the ETI Act and the AJCA	1989-2006	national	$2.2 billion	0
B. Subsidies that are not subject to WTO dispute either because they are out of the scope of dispute or out of the time scope of the case					
1) Other benefits not specific to aerospace industry but received by Boeing					
State of South Carolina	Up-front payments for relocation, property and sales tax exemptions, income tax credits, utility tax discounts, targeted employment credits, training grants, infrastructural support	2009-	regional/state local	>$500 million	0
State of South Carolina - Charleston County	Property tax abatements	2009-	local	$360 million (over 30 years)	0
State of Washington I	Infrastructural support (addition to port or Seattle) Property tax abatements, sales tax exemptions, income tax credits, utility discounts, hiring assistance	2006-	regional/state local	>$3 billion (over 20 years)	0
State of Washington II	Business and occupation and property and sales tax exemptions	2024-	regional/state local	~$8.7 billion (over 16 years)	0
State of Illinois	Property tax abatements, income tax credits, job training grants, energy grant, infrastructural support	2001-	regional/state local	~$50 million	0
R&D tax credits	Tax breaks deducted from the federal income tax	annual	national	Annually ~$150 million on average between 2005-2014	0
Excess tax benefits from stock options	Tax breaks deducted from the federal income tax	annual	national	Annually ~$100 million on average between 2005-2014	0
2) Other benefits specific to aerospace and airlines industries (Boeing may also be a direct or indirect beneficiary)					
US Department of Commerce	R&D grants under the Advanced Technology Program, access to facilities, equipment and employees	1991-2004	national	unknown	0
US Department of Labor	Worker training grants Edmonds Community College (for Boeing 787)	2004	national	$1.5 million	-
EX-IM Bank	Cheap loans to foreign countries and companies seeking to buy US goods	annual	national	unknown	-

Source: WTO reports, Airbus and Boeing annual reports and other internet sources

The comparison of government subsidies for Boeing and Airbus shows that the role of the state in supporting business enterprises has multiple dimensions. Figure 2.12 below provides a categorization of three dimensions of government support for new aircraft development throughout the last 30 years that helps to understand the extent of the role of governments in encouraging business enterprises to invest in innovation and in complementing their efforts during the process. The spatial dimension defines the funding body's geographical extent. The dimension of time defines the moment of subsidy involvement along the product development period which is the key activity supported by governments. The liability dimension defines the degree of the potential charges of the subsidy to the company.

Figure 2.12: Categorization of government support to commercial aircraft industry

Spatial Extent	**Temporal Extent**	**Financial Liability Extent**
Local (municipalities/ counties)	Infrastructural supports/investments before the program launch	Risk free grants
Regional (states/regions)	R&D supports/ permissions before or during the program development	Tax credits/reductions
National (countries)	Tax breaks/ exemptions during or after the program development	Debt forgiveness
International (international organizations)	Employee hiring and training supports during or after the program development and its execution	Interest free or low-interest loans Equity infusions

Source: Author

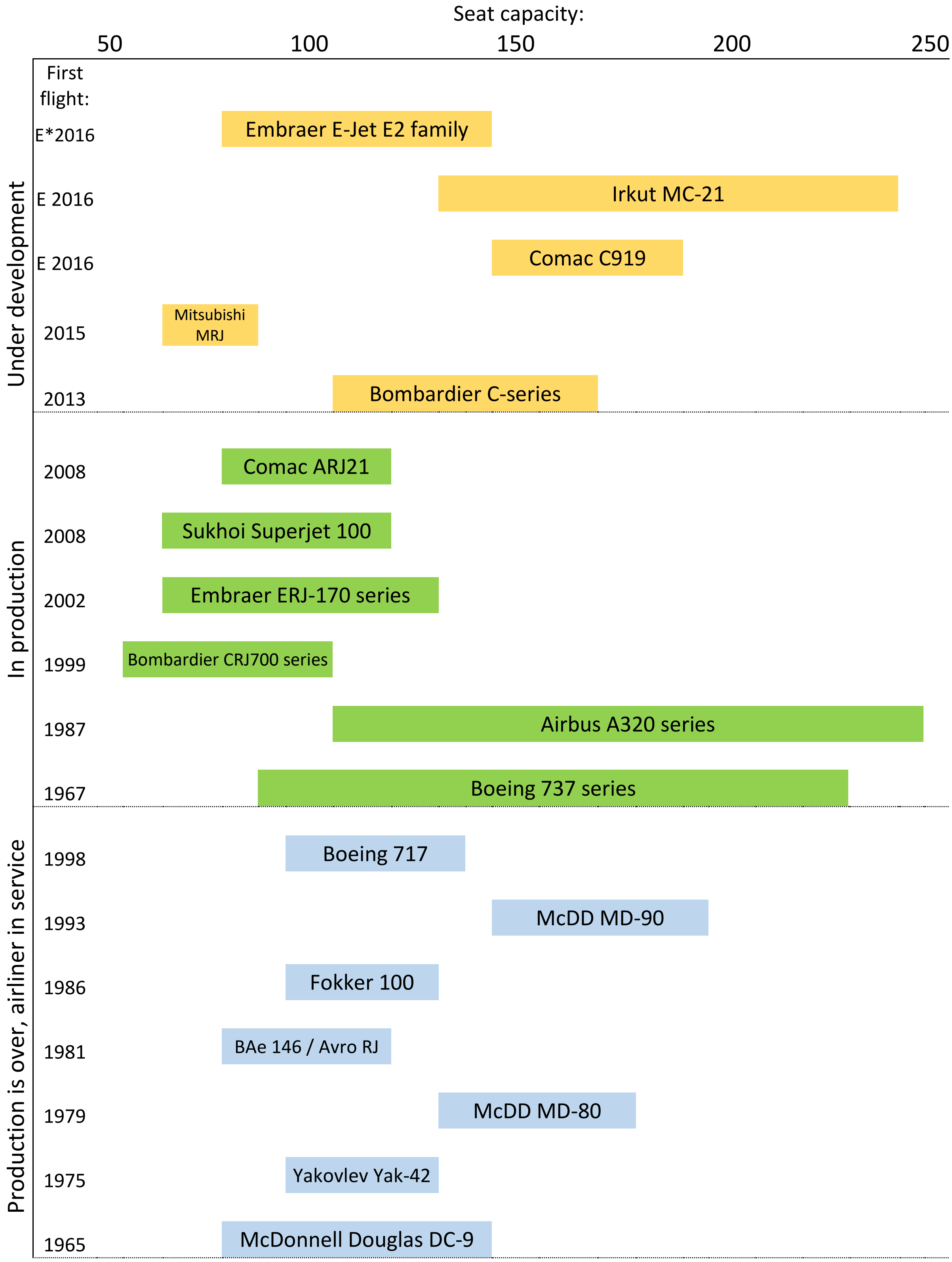
2.9 Conclusion of the chapter

Government support continues to be a major determinant for the well-being of national aerospace industries all over the world. The efforts to develop new capabilities in aircraft development and manufacturing will continue to be maintained through the financial commitment of governments. The regulatory role of governments will also continue to shape the structure of the industry with specific emphasis given on different aspects of aircraft. For example, the introduction of new air traffic control systems like Next Generation Air

Transportation System in the US and the ongoing Single European Sky ATM Research project in Europe will have important implications on aircraft manufacturing especially for avionics firms and OEMs.

Long-term support is even more critical now than ever, due to a market transformation on the doorstep. The ongoing development programs of Chinese, Brazilian, Canadian, Japanese and Russian OEMs will bring a completely different product market structure in the 2020s. Forecasts predict a steady increase in commercial aircraft sales in the coming two decades assuming no negative events that would disrupt the order and production pattern (Deloitte, 2014). After they overcome the challenges to finalize product development efforts, manufacturers have to maintain a steady flow of production and to establish a record of reliable and safe operating history. In these forecasts it is assumed that some of the orders will be meet by new entrants with small segments where more than 80 percent of the deliveries happen. The ongoing development programs of Chinese, Brazilian, Canadian, Japanese and Russian OEMs will bring a completely different product market structure in the 2020s. Figure 2.13 below displays the latest situation of the commercial aircraft manufacturing's short to medium range segment where the strongest competition is going to happen by the end of the decade. The second major challenge is the rising role of component suppliers and OEMs from the developing economies which will bring new dynamics to the competition in aerospace products. Having only smaller component manufacturing agreements so far in the latest programs of Airbus and Boeing, with the help of their respective governments, they would emerge as systems suppliers in the years to come.

Figure 2.13: In service or in development short to medium rage jet aircrafts in the world



The list contains only short to medium range, in service/in development, jet airliners, produced at least 50 or more units after 1960s when the jet propulsion aircraft design was established as a dominant aircraft technology. *E: expected

Source: Airlines.net

Thus how dominant Western aerospace and its two leading firms Airbus and Boeing are going to be over the next decade is a major question of the future aerospace industry research to be answered. However, this study aims to analyze first how the business models of these two companies have changed over the past decade or so and the implications for innovation and competition between them. Only a comparative analysis of the recent history of Western commercial aircraft manufacturing may provide insights for the future prospects of the global aerospace industry. This chapter tried to show the major characteristics of aerospace and commercial aircraft manufacturing industries with an aim to cover the entirety of industrial dynamics which are, in general, selectively highlighted by different conceptions of industry with varying disciplinary lenses and analytical purposes (Sako, 2008). After this industry level discussion, the following chapters focus on the comparative dynamics of Airbus and Boeing utilizing the business model framework identified in the previous chapter.

Second Part

Systems Integration as Business/Productive Model of Airbus and Boeing

Chapter Three

‘Strategy’ component of Airbus and Boeing systems integration business/productive models

3.1 Introduction

Following Chandlerian tradition, strategy can be defined as the planning and carrying out of the growth of organizations (Chandler, 1962). The main purpose of modern business enterprise is to transform productive resources into goods and services to be sold. For a business enterprise, planning and carrying out productive activities depend on the set of decisions on resource allocation and their impacts on productive returns. These implications are conditioned by different types of uncertainties depending on the form of activity, by the environment in which the enterprise acts and most importantly, by the motives of corporate decision-making.

Business firms need coherent strategies, to a large extent, defining the ways in which the firms are organized and governed (Nelson, 1991). Especially because it is confronted with uncertainties, a business form necessitates a coherent strategy to deal with innovation process as a whole (Lazonick, 2005). Actors who hold strategic control over the firm make decisions over the allocation of resources to create certain possibilities to cope with different types of uncertainties (Lazonick, 2013) that are mentioned in the previous chapter. The control, in that sense, constitute the set of relations that gives decision-makers the power to allocate resources. Innovation requires that the actors who exercise strategic control have the ability to recognize the strengths and weaknesses of their firm as well as technological opportunities and competitive challenges (Lazonick, 2013).

In modern business enterprise, these actors are predominantly the top executives even though other forms of decision making like government involvement or workers’ control are still existing in different contexts under different social conditions. For example, aerospace and defense industries in the world were under tight control of national governments in terms of their strategy and structures for a long time throughout the twentieth century (Lawrence and Braddon, 1999; Todd and Simpson, 1986). The extent of the government control has been effective on a wide range of activities and actions, from the content and execution of research partnerships to the selection of plant locations (Todd and Simpson, 1986), albeit with a decreasing intensity (Frigant et al., 2006; Moura, 2007). Compared to the US, the role of government as industry organizer had always been much more highlighted in Europe (Jalabert, 1974; Muller, 1988). The size and content of the decisions over the allocation of resources and the power of a specific firm within its industry or in general economy shape the magnitude of the impact of firm's strategy. Decisions over outsourcing and the structure of value chains they shape, capital and R&D investments they realize, the extent of skills pool they control and further develop, and the financial power they exert to fund innovation are all outlined by the strategy of the firm. The involvement of Western manufacturing firms in changing their corporate strategies has had great implications over these aspects. This chapter discusses the impact of this change in Airbus and Boeing in the last two decades on strategy component of their business/productive models.

3.2 Product policy in commercial aircraft manufacturing

Strategy defines how a business firm acquires a certain share in the product markets where it competes with other firms or, in other words, how to establish an advantageous position in the market. For an innovative firm, the role of strategy is to render the firm capable to define its output and price while transforming technologies and accessing markets (Lazonick, 2013) or synonymously, the creation and use of competitive advantage (Teece, 2010a). Thus a major element of strategic decision concerns the scope of the business portfolio of products and the markets being served (Sako, 2006). The peculiarities of the commodity that the business firms produce are crucial to the discussion of the business/productive models within a specific industry. Markets for different products, their segments, design and range of the products on offer, and sales objectives are the elements that characterize productive models' boundaries and dynamics of change (Boyer and Freyssenet, 2000a). The decisions over which capabilities are going to be built and how and when they are going to be deployed are conditioned by the positioning in product markets (Teece, 2010a). It is especially relevant for an industry like aerospace where the corporate strategy is strictly bounded to new product launch.

Today a new commercial aircraft costs more than $15 billion with a development period of five to seven years. The product life is slightly above 25 years on average (Forsberg, 2012) and together with its production period, it is not unusual for a successful aircraft program to stay in service for 40 to 50 years. Aerospace companies usually put at risk their own entity during a new product development. Any plans to initiate a new aircraft program bring along important strategic decisions on resource allocation, productive organization and financing.

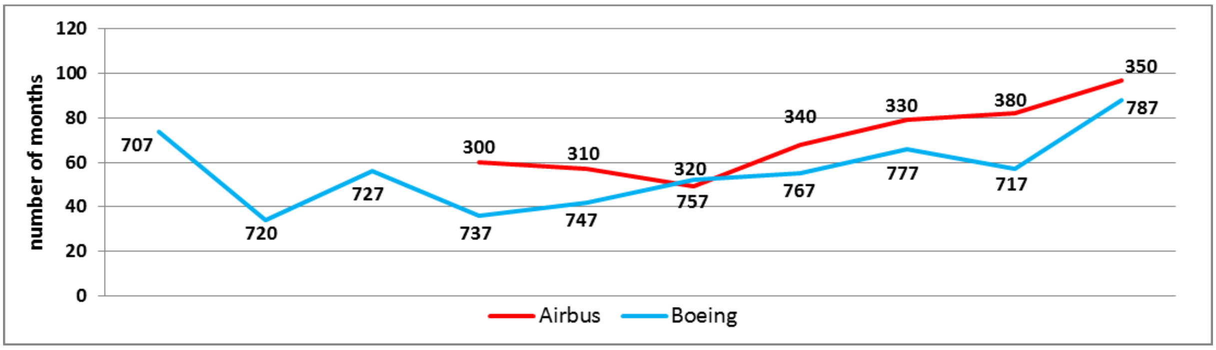
Airbus and Boeing follow the industry old logic of having commercial aircraft families with several aircraft models having different capacities to carry from 100 to 500+ passengers. The aim is to avoid being restricted to a single model that prevents any opportunity of economies of scale required to ease the heavy burden of high-cost investments, manufacturing and marketing as airlines generally prefer to have the same kind of aircraft families in their fleet. Today both companies have different aircraft models serving in every segment of the industry and continue to offer new or upgraded models as well as derivatives of existing ones. Faced with a very strong pre-market uncertainty, companies have to do a detailed market research and cost/benefit calculations that may extend over several years, sometimes without success. Response of customers to pre-launch propositions provides important feedback for product launch decisions[8]. Airline deregulation, fuel costs, and new entrants to the market are some historical factors affecting company decisions to initiate a new aircraft program (Gillett and Stekler, 1995).

Another decisive factor is the availability of new technologies to be integrated and access to them (Szodruch et al., 2011). One of the biggest technological factors in a new product launch decision is the availability of new engine models or engine manufacturers' existing plans for new product development. When OEMs plan to launch a new aircraft program, they have to consider a set of options which includes but is not limited to the segment choice depending on the current market needs (narrow body - wide body, short haul – long haul), degree of novelty (a highly innovative new product vs. an upgrade of an existing one), diversity of models/versions (different configurations with different numbers of seats, passenger and

[8] For example, after three years of negotiations with its Japanese partners, Boeing cancelled its promising 7J7 program due to a lack of interest in the changing economic climate in 1987. It also cancelled its Sonic Cruiser project in the early 2000s and opted for 787. Airbus, on the other hand, evaluated different options for around 10 years after it finally decided to develop its super jumbo A380 in 2000. As another example from Airbus, after receiving dissatisfied returns from customers on its first A350 proposition as an upgraded version of its A330 aircraft, the company had to come with a brand new design in late 2006.

cargo versions), targeted geographies (world market, home market, Asia, China), pre-launch negotiations and collaborations with potential partners, and a market research with sales objectives (a certain number of aircraft sales as a threshold for positive financial returns). The history of commercial aircraft manufacturing is basically an account of winners and losers with few successful and profitable aircraft programs and many failed attempts[9]. Table 3.1 lists all successful models of Airbus and Boeing with program launch and introduction dates since the beginning of their jet aircraft manufacturing. One curious observation is the increase in the length of aircraft development since 1960s which is consistent with rising technological and organizational complexities thanks to the incessant introduction of new technologies and the challenges of sophisticated supply chains. Figure 3.1 shows the increase in the length of development period of new product launch of Airbus and Boeing in a historical order.

Figure 3.1: Length of the development period for new aircraft models of Airbus and Boeing



Source: Related Airbus and Boeing web pages and airliners.net

[9] Limited success of some programs like Sud Aviation's Caravelle, Hawker Siddeley's Trident or British Aircraft's BAC-111 helped these European manufacturers to keep and to upgrade jet aircraft manufacturing capabilities which enabled them or their successive companies to initiate and run the Airbus program.

Table 3.1: Launch, first flight and introduction dates of all successful Airbus and Boeing commercial aircraft programs

AIRBUS

Model	Program Launch	First flight	Intro-duction	Launch to Intro-duction (in months)
A300B	01.05.1969	28.10.1972	30.05.1974	60
A300-600	1980	07.08.1983	03.01.1984	
A310-200	06.07.1978	03.04.1982	01.04.1983	57
A310-300		08.07.1985	16.12.1985	
A320-100/200	02.03.1984	22.02.1987	28.03.1988	49
A321-100	11.01.1989	11.03.1993	27.01.1994	
A319-100	1993	25.08.1995	04.01.1996	
A318-100	09.11.1998	15.01.2002	01.07.2003	
A320neo	12.01.2010	25.09.2014	25.01.2016	
A321neo	12.01.2010	09.03.2016		
A319neo	12.01.2010			
A340-300	05.06.1987	25.10.1991	15.03.1993	68
A340-200	1987	04.01.1992	29.01.1993	
A340-500	16.06.1997	02.11.2002	23.10.2003	
A340-600	16.06.1997	23.04.2001	08.01.2002	
A330-300	05.06.1987	02.11.1992	17.01.1994	79
A330-200	11.01.1995	13.08.1997	30.04.1998	
A330neo	14.07.2014			
A380-800	19.12.2000	27.04.2005	25.10.2007	82
A350-900	01.12.2006	14.06.2013	22.12.2014	97
A350-800	*01.12.2006*			
A350-1000	*01.12.2006*			

BOEING

Model	Program Launch	First flight	Intro-duction	Launch to Intro-duction (in months)
B707	30.08.1952*	20.12.1957	26.10.1958	74
B707-220	?	06.11.1959	12.01.1959	
B707-320	?	01.11.1959	08.01.1959	
B707-420	?	20.05.1959	03.01.1960	
B720	07.01.1957	23.11.1959	07.05.1960	34
B727	01.06.1959	09.02.1963	01.02.1964	56
B727-200	08.01.1965	27.07.1967	12.01.1967	
B737	19.02.1965	09.04.1967	10.02.1968	36
B737-200	04.05.1965	08.08.1967	28.04.1968	
B737-300	26.03.1981	24.02.1984	28.11.1984	
B737-400	06.04.1986	19.02.1988	15.09.1988	
B737-500	20.05.1987	30.06.1989	28.02.1990	
B737-600	15.03.1995	22.01.1998	18.09.1998	
B737-700	11.01.1993	02.09.1997	17.12.1997	
B737-800	09.05.1994	31.07.1997	22.04.1998	
B737-900	09.10.1997	08.03.2000	15.05.2001	
B737-900ER	18.07.2005	09.05.2006	27.04.2007	
B737 MAX 7	30.08.2011			
B737 MAX 8	30.08.2011	29.01.2016		
B737 MAX 9	30.08.2011			
B747	25.07.1966	09.02.1969	22.01.1970	42
B747SP	09.10.1973	07.04.1975	03.05.1976	
B747-200	19.12.1968	10.11.1970	15.01.1971	
B747-300	06.11.1980	10.05.1982	03.01.1983	
B747-400	22.10.1985	29.04.1988	29.01.1989	
B747-400ER	19.12.2000	31.07.2002	31.10.2002	
B747-8	14.11.2005	19.08.2011	10.12.2011	
B757	31.08.1978	19.02.1982	01.01.1983	52
B757-300	15.09.1996	08.02.1998	03.10.1999	
B767	01.02.1978	26.09.1981	08.09.1982	55
B767-200ER	02.01.1982	03.06.1984	26.03.1984	
B767-300	09.01.1983	30.01.1986	25.09.1986	
B767-300ER	01.01.1985	12.09.1986	19.02.1988	
B767-400ER	01.01.1997	10.09.1999	29.08.2000	
B777	08.12.1989	12.06.1994	07.06.1995	66
B777-200ER	29.10.1990	10.07.1996	02.06.1997	
B777-200LR	29.02.2000	03.08.2005	27.02.2006	
B777-300	26.06.1995	16.10.1997	22.05.1998	
B777-300ER	29.02.2000	24.02.2003	29.04.2004	
B777-9X	18.11.2013			
B717	10/1/1995**	02.09.1998	12.10.1999	57
B787	26.04.2004	15.12.2009	26.10.2011	88
B787-9	10.01.2007	17.09.2013	07.08.2014	
B787-10	18.06.2013			

Source: Related Airbus and Boeing web pages and airliners.net, *launch of Dash-80, the early prototype of B707, **launched as MD-95 by McDonnell Douglas before its merger with Boeing

3.3 Where to find capabilities? In-housing vs. outsourcing

Beyond the simplification of cost and availability constrained make-or-buy decisions, during a new product launch or part of their reorganization efforts for ongoing production lines, OEMs may resort to restructuring their internal and external production organization in response to the magnitude of capital investments and resource reallocation. Technological requirements of a new design, the extent of accumulated in-house capabilities and existing opportunities in the form of R&D efforts of current or prospective partners are main factors of reorganization. These aspects are also the most elaborated ones by innovation studies.

In the commercial aircraft industry, new product development has been strictly related to mobilize internal capabilities of firms including the efforts of thousands of designers and engineers to design and develop an innovative aircraft addressing new and sophisticated needs. It also includes the setting up an organization capable to manage the development of the aircraft and its production line to be commercially successful. Very large initial fixed capital investment, high unit costs, complexity of products, heavy-engineering, high expectations for safety, reliability and performance, and requirements of extensive coordination and communication entail very strong internal capabilities for OEMs (Sorscher, 2011). The basic success of Airbus and Boeing resides on their capabilities to address specific customer demands with sustained production runs that help them to convert their high fixed costs into low unit costs.

Beside internal capabilities, OEMs increasingly form partnerships with other firms which provide complementary skills and resources for new product development. In the business literature (Freytag et al., 2012; Quélin and Duhamel, 2003; Quinn, 1999; Sako, 2005) the activity of collaboration is usually discussed around the concept of outsourcing which is generally defined as the operation of shifting a part or some parts of a complete production process to an external supplier in different forms of agreements depending on the cost, quality and extent of the work assigned to the supplier. It may also involve strategic decision-making as with outsourcing, companies transfer some part of their work already performed or can still be performed with the help of internal resources and capabilities. Mutual dependence, commitment, intense information exchange, and trust are main determinants of the governance of the relationship (Sako, 2005).

When corporate executives and business media started to use the word outsourcing in early 1980s as an alternative to the word subcontracting which was the word used for externalization of productive activities, the highlighted reason was not so different from that of subcontracting. The purpose was to lower production costs when sourcing components from suppliers is cheaper than sourcing them internally. It was initially used to describe such practices in the US automobile industry which was under pressure of strong competition with Japanese counterparts (Sako, 2005). In the meantime, subcontracting continued to be defined mainly as a work order for manufacturing and a form of collaboration (Amesse, et al., 2001) inspired mainly by emerging approaches of the period including transaction costs economics (Williamson, 1981) which theorized inter-firm relationships as alternatives to vertical integration (Esposito and Passaro, 2009). In late 1990s and early 2000s, a group of business scholars introduced the concept of strategic outsourcing as a superior form of subcontracting in which firms should also resort to outsourcing of activities that create competitive advantage for the firm. It is not a choice but a necessity to outsource such activities in order to leverage the impact of internal investments and complementary capabilities (Alexander and Young, 1996; Bryce and Useem, 1998; Quélin and Duhamel, 2003; Quinn, 1999, 2000) as well as to enlarge shareholder value (Bryce and Useem, 1998). It was the time to outsource even technologically critical parts and components as the interaction capabilities of companies substantially grew compared to previous periods of in-house research and development perspective (Quinn, 2000) and the access to the industry-leading external competencies and expertise has become more critical than ever for companies (Kakabadse and Kakabadse, 2002). Thus, outsourcing has become a requirement rather than a choice because of the technological advancements and specialized knowledge that are required to be integrated into the new products whereas they are beyond the reach of the companies' existing capabilities. Planning and carrying out of innovative activities also involve the consideration of other organizations' resources and potential (Hobday et.al, 2005; Pavitt, 2003; Prencipe et al., 2003). It is now a prerequisite that any investment decision need to consider this potential outside the walls of the organization.

In its historical context outsourcing seems like an indispensable practice within broader productive organization. However, it contains a variety of unpredicted risks and potential damages to the performing company.

The greatest risks of outsourcing are the loss of strategic flexibility, being leveraged by suppliers, supply interruptions and quality issues, a fall in employee morale, a loss of internal coherence, the loss of intellectual property rights (Lonsdale and Cox, 2000); poor judgment over the outsourcing decision, selection of the wrong supplier with limited capabilities, poor communication between parties, absence of exit strategy, overlooked hidden costs, losing control of the overview of the outsourcing process (Barthelemy, 2003); the risk of losing vital knowledge related to core competencies (Hoecht & Trott, 2006).

More elaborative accounts on the risks of outsourcing emphasize the erosion of systems and components related competencies of the internal labor force due to lack of learning by doing opportunities beyond design activities as a 'key lever for acquiring and maintaining the detailed knowledge' (Zirpoli and Becker, 2011); and uncertainties over the resilience of the supply chain through sustainable allocation of R&D funding and necessary financial resources for other operational requirements with increasing role of suppliers in R&D, project management, certification, etc. (Sherry and Sarsfield, 2002). Some scholars also highlighted the risks related to the loss of capabilities which would help to develop next generation technologies. Because of the strong association of process and product innovation, outsourcing, and especially outsourcing abroad, would create a chain reaction of losing productive capabilities at home. Without necessary capabilities to maintain process innovation and manufacturing, economies and equivalently their OEMs can lose their ability to develop new products and to innovate in general (Pisano and Shih, 2009).

The transformation of the old motive of cost-cutting, in the words of the business literature, into a general trend of acquiring the discipline of financial markets in their businesses and enlarging shareholder value (Bryce and Useem, 1998; Quélin & Duhamel, 2003) has also been criticized by scholars and industry experts.

Defining the renewed approach to outsourcing as part of a corporate restructuring process started in the 1980s, these scholars and experts highlight the role of financial motives. As long as the governance of supply chains and outsourcing decisions are issues of corporate governance (Milberg, 2010; Sturgeon, 2008), the rise of the shareholder value model of corporate governance played a part in promoting this type of corporate restructuring (Sako, 2005). The marriage of the reinterpretation of Japanese cost cutting strategies of permanent reduction of costs and rapidly emerging Anglo-Saxon schemes of maximizing shareholder value led business firms of every type to act increasingly through financial motives at the expense of in-house investment and capability development.

This model of shareholder value is mainly interpreted in the achievement of target cost savings and improved return on assets, cost of capital and certain ratios like Return on Net Assets (RONA). Outsourcing as well as divesting have helped to achieve these targets (Sako, 2005). The rising ability of firms to disintegrate production through outsourcing and offshoring has allowed business firms to maintain cost mark-ups and thus higher profits and higher shareholder value distribution (Milberg, 2008).

In aerospace, similar concerns have been expressed by industry specialists. As early as 2001, a Boeing engineer at Phantom Works, the main R&D division of Boeing behind the conceptualization and creation of advanced technology products, criticized the potential inclination of Boeing towards extensive outsourcing by investigating the motives and potential outcomes through examples from McDonnell Douglas (Hart-Smith, 2001). His first critique was the inability of contemporary accounting practices to allow un-allocable costs of outsourcing which later appear in other items like product support or sales. Because it is no longer identified as an in-house work, charges related to integration of outsourced work are allocated as overhead to remaining in-house work. This misrepresentation of true costs furthers the illusion that outside production is cheaper than anything done inside, building the pressure to ship even more work offsite, until there isn't any left in-house. His second critique was the excessive focus on Return on Net Assets as a popular performance metric of the time which led the aerospace industry into a state of massive outsourcing with the aim to keep necessary capital expenditures low. With lack of deep understanding by financial analysts on what makes companies different, the misapplication of such financial assessment tools has potential to do great harm to the livelihoods of far too many people (Hart-Smith, 2001). From a shop-floor perspective, the pursuit of lower costs would harm the engineering community who represents the source of intangible value, critical for the long-term success of an aerospace company. Any decision minimizing the value is a threat to long-term competitiveness (Sorscher, 2002).

Thus, outsourcing cannot be limited only to a cost calculation logic. It is part of a broader capitalist transformation since the late 1970s in manufacturing industries and it contains elements of innovation, organizational learning, corporate governance and mutual commitments to specific collaborations to extend the burden of value creation to all the parties involved. It is unsurprising that the development of these long-lasting inter-firm relations helped suppliers to gain necessary competences in specific fields and to maintain them, which led scholars and practitioners to highlight such terms as network relationships or strategic alliances from late 1980s and early 1990s and the internationalization of production as a major element of inter-firm relations and competitiveness (Sturgeon, 2008). Nevertheless, the basic questions around strategy are still the same for new contexts. The extent of outsourcing and offshoring and the likely impact of such decisions on organizations and the societies building these organizations can never be detached from the ability and actions of business firms to create and capture value in ever globalized production (Sako, 2005). Thus starting the discussion with the basic questions of business strategy is still relevant. These questions are how do firms create and capture value in globalized productive organization? What activities and functions should be kept in-house and what activities and functions should be kept at home (i.e. within national borders)? What is the likely impact of these decisions on home and host societies, and in what ways should corporations take these impacts into account when they make their decisions?

3.4 Organizing production in aerospace

The literature on outsourcing in aerospace is no different than the general discussion on industrial outsourcing and collaborations (Dussauge and Garrette, 1995; Esposito and Passaro, 2009; Monroy and Arto, 2010; Williams et al., 2002). Here again outsourcing is strictly connected to the integration of production activities within or outside the boundaries of a firm which is responsible for organizing the entire production process from conception to delivery of the product to customers. The integration also includes a joint capability development process for the actors involved. The sustainable growth of suppliers with the help of OEMs is the main outcome of collaboration and strategic decisions. Commercial aircraft production is a very appropriate example for explaining this industry-level integration with important particularities that are incompatible with mainstream approaches to outsourcing which mainly claim that it happens on a field with limited interaction until the agreement is set between partners (Bryce and Useem, 1998; Kakabadse and Kakabadse 2000; Quinn, 2000).

Aircraft manufacturing's mass outsourcing which also includes design and development, in many instances, is the result of joint efforts of OEMs and suppliers to transfer existing capabilities to suppliers or to help them develop their own ones which are more than a search for advanced capabilities outside the boundaries of the OEM. Thus, in the commercial aircraft industry, outsourcing is rather a historical process of collective learning led by OEMs and facilitated by suppliers' own efforts even though basic reasoning of cost-cutting is also relevant in many other situations. Product development in aircraft manufacturing has primarily become an industrial level undertaking decided on a global level. Compared to 30 years ago, many companies from developing economies have also become important actors in aircraft supply chains with different capabilities in specific or broader areas within aerospace.

The decisions on collaboration and outsourcing are based on a complex set of factors. Besides the historical course of collaboration between existing partners over specific areas, strategic decisions over new product development and its division of labor are influenced by the dynamics of capability development in response to technological change and resulting reallocation of resources; geographical expansion of production and consumption together with demand-related elements like offsetting; IPR-related issues; industrial relations; government involvement into decision-making in different forms; and existing sources of finance for the new aircraft development.

Thus, in the case of commercial aircraft industry, corporate decisions on which capabilities are developed in-house and which ones are procured during a new product development program are shaped historically and usually characterized by social and political factors. The industry is dominated by a limited number of OEMs and specialized component makers from a limited number of economies, predominantly from the industrialized world while the share of developing world is slowly increasing. China and Brazil are the two countries from the so-called Third World with OEM capabilities (PMI, 2009). Each of these aerospace giants, either an OEM or a major component/systems provider manages its own global supplier network. Traditionally, manufacturers of original equipment have defined main requirements of a specific component/part of an aircraft, designed it and then assigned a supplier to develop and manufacture in collaboration. Considering the increasingly complex and integrated architecture of commercial aircrafts, procurement has been performed through partnerships and collaborations which usually continued in following programs. New designs containing advanced technologies like those in electronics or materials require new capabilities that can also be developed and utilized outside of the walls of OEMs. In the case of the US aerospace, development of the US industrial base as well as the military industrial complex throughout the twentieth century accumulated a tremendous skill base utilized by firms which experienced a steady growth through rising commercial aviation and increasing defense budgets. Dual applications of aerospace technologies on civilian and military products provided these firms with desired flexibility to advance their R&D activities and related skills development efforts including suppliers. The cooperation among US firms helped them to develop their capabilities in specific areas and also provided them to procure for foreign OEMs like Airbus and other global actors producing airplanes of different sizes. Like Brazilian, Chinese or Russian OEMs today, Airbus was also helped by US suppliers of critical components for its early programs (McGuire, 2007). Later, the collaboration between OEMs and suppliers progressively extended beyond national borders. Strictly connected to national efforts to build and maintain a domestic aerospace industry which is generally organized around a single company or a few of them, countries which do not have an OEM, established strong aerospace footholds thanks to their participation to collaborative civilian and military projects.

In the meantime, integration or disintegration have had different forms depending on national contexts, the course of development of domestic actors and choices over corporate strategy. In effect, a study on the comparison of integration and supplier organization of Airbus and Boeing is a collection of differences and similarities. Before their convergence towards systems integration with their latest programs in the second half of 2000s, they followed quite opposite directions between 1970 and 2000. Being a Pan-European project, Airbus was formed as a joint venture of four different aerospace firms from four European countries and the history of the company is marked with a progressive integration of different functions scattered across different plants and units managed with different methods, rules and regulations. Nevertheless, the work share among partners was not arbitrary. The specialization of different countries in different parts of the complete Airbus aircraft family reinforced economies of scale with otherwise expensive automated and cost-saving equipment (Hart-Smith, 2001). EADS, the previous name of today's Airbus Group, founded in 1999 to further consolidate existing manufacturing and administrative functions while reorganizing its supply chain with larger duties for a smaller number of suppliers in its new programs. In contrast, Boeing as a highly integrated company until late 1970s progressively outsourced large sections of new models particularly to its Italian and Japanese partners. Starting with 747 offset-style outsourcing to Japan in the late 1960s, in its latest program 787, Boeing outsourced more than two-thirds of the value of the aircraft to its Japanese, Italian and other national and global partners. Due to the fact that even a modest advance of technology is obtained through large investments (Esposito, 2004), long lasting partnerships are an important way to confront both technological and financial challenges.

As a result, the stronger than ever emphasis on globalized supply chain organization and service and communications-related capabilities in the systems integration business model has been progressively created by OEMs/systems integrators throughout their product development efforts. With stabilized and extended networks beyond single development programs, OEMs had the possibility to forgo in-house capabilities in developing and producing many complex systems. Early explanations to explain outsourcing due to the increasing risks because of rising development costs or acquiring access to foreign markets through offsetting (Mowery, 1988) later supplemented with further role of internationalization of productive efforts in outsourcing through new opportunities (Esposito and Passaro, 2009; Kechidi and Talbot, 2013).

While the current orientation towards systems integration looks similar for both firms, there are important differences between two firms depending either on existing competences or the willingness to develop new ones. For example, when Airbus decided to launch A350, it was highly probable that it would develop and produce the composite wings in-house (in its UK plants) as the company already accumulated necessary capabilities to design and develop all-composite wings through its previous work on A400M military transport aircraft. In contrast, Boeing outsourced the development and production of B787 composite wings to its Japanese partners as a further stage of the collaboration. Neither Boeing nor its Japanese partners had a fully developed capability package for an all-composite wing in advance but the extensive financial support provided by Japanese government for the development of wings and other necessary infrastructural measures gave them necessary impetus to bid for Boeing contracts (Pritchard and MacPherson, 2004). Only in 2014, Boeing turned to develop composite wing manufacturing capabilities in-house with a controversial decision linked to a labor relations dispute to upgrade its 777 model. The details of the dispute are provided in the following chapter.

Thus the systems integration model depends upon the commitment of OEMs to share their work with others together with the willingness of those partners to develop required capabilities. As a result, in the last two decades, we observe a convergence of two firms considering extensive outsourcing of design, development and manufacturing which give its essence to systems integration although the extent of it may vary. Risk-sharing partnerships in the very early stages of product development over ever larger components and systems became a norm for both firms. Earlier involvement of partners to design and develop integrated components has also allowed suppliers to consolidate their own supply chains. However, this new orientation also brought potential risks and uncertainties over the resilience of these chains either in the development or production periods. Contracts with suppliers contain certain elements including tightly fixed delivery dates of specific amounts of parts and components. Multiple examples in the development and production of aircraft by Airbus and Boeing show that extensive outsourcing or networking bring about their own authentic contingencies. Any problem occurring at some part of the chain could cause the entire program to come to a halt or at least diverge from its schedule. The growth prospects of firms also became interdependent with the sharing of innovation.

Another issue is the degree of power that OEMs exert their suppliers either at the time of the contract signed or afterwards. Airbus and Boeing today have extensive power over their suppliers in not only defining the specifications of parts, components and systems to be produced but also the form of contracts signed, costs and profits shared. Increasing degree of interdependence through tight delivery schedules, quality and cost reduction requirements highlight the tense character of supply chains. Depending on the degree of power asymmetry between partners (Gereffi et al., 2005), Airbus and Boeing's ability to impose continuous quality improvements or cost reductions defines the pressure on suppliers to profit from their efforts not only to manufacture, but also progressively to design and develop assigned parts and components. As in the case of Boeing, OEMs even have the power to regulate merger and acquisition activities of their suppliers through assignability clauses that they include in contracts. The high degree of involvement of financial objectives like increasing margins through asking cost reductions creates extra stress and problems of confidence between parties[10].

On the other hand, the dynamics between suppliers and OEMs are not always unidirectional and based on captive or relational forms highlighted by the GVC literature in general (Starosta, 2010). Other examples include McDonnell Douglas' excessive outsourcing which resulted in suppliers' capture of most part of the profits and the failure of the OEM to sustain the conditions that make launching new products possible (Hart-Smith, 2001). In that sense, suppliers are not always passive and obedient, and technology transfer is not always one way (Amesse et al., 2001). They regularly look for upgrading opportunities and in the case of aerospace this is even more the case because technological potential which provides opportunities for firms in an exponential manner. The progressive involvement of Japanese manufacturers in Boeing's 7-series since the early 1960s, supported by Japanese government (Sakai, 2004; US Congress, 1991), until they became capable of developing and manufacturing cutting edge technologies like composite wings or power systems in Boeing's latest 787 program. Similarly, companies from countries that traditionally have lacked aerospace capabilities like Malaysia, Turkey or South Africa are trying to enter in and later move further in supply chains of latest programs of Airbus and Boeing. The best illustrative cases are their latest programs of Boeing 787 and Airbus A350.

3.4.1 Development strategy of Boeing 787

Before it was officially launched 787 as a new commercial aircraft development program in early 2004, Boeing had already performed a long but usual process of market research on different designs of different models. In the first place the company proposed its Sonic Cruiser program in 2001, built on NASA-funded supersonic small commercial aircraft research project Super Sonic Transport in the 1990s. But later in 2002, Boeing discarded the program due to lack of customer interest for a faster but costly airplane as rising operating and fuel costs attracted airline companies for more efficient designs. As a result, Boeing launched another research program called Project Yellowstone that it had been working alongside Sonic Cruiser

[10] "Boeing's Partnership for Success strains supplier relationship" February 16, 2014, Leeham News

utilizing similar technologies. It was later renamed 7E7 in 2003 and finally 787 Dreamliner in early 2005 after the official launch.

Before the launch of the program Boeing had to figure out the sources of finance for the product R&D and the organization of the supply chain. Alongside the early designs of Sonic Cruiser and 7E7, long before the official launch of 787, Boeing signed various technology development agreements with its Italian and Japanese partners as well as several US component suppliers. In effect, as early as 1997, the year in which it merged with McDonnell Douglas, the company set its Aircraft Creation Process Strategy (ACPS) which laid the conceptual groundwork for 787's global production system through the lessons learned from 777 and 747-500X/600X programs (Wagner and Norris, 2009). The aim was to develop a new aircraft in a faster and cheaper way. While faster meant improved design and development techniques through standardized processes and platforms, cheaper was mainly about assigning more responsibility to suppliers[11]. Advocated by ex-McDonnell-Douglas CEO Stonecipher, return on net assets, a ratio which is utilized to identify how much money is being made in terms of the work required, was again the main motivation to keep development and production costs low (Ostrower, 2011). In effect, the plan allowed Boeing to keep capital expenditures unusually low during the development of 787 compared to its previous programs and Airbus' concurrent ones.

To keep costs down, early involvement of suppliers was essential. After the initial design of the aircraft, Boeing announced its major suppliers before the official launch of the program in order to figure out the potential program costs to Boeing and let suppliers organize their own supply chains and search for funding from their respective governments. As early as 2003, it established a council to work jointly with suppliers on the program and set up a virtual network linking together different labs around the world to coordinate design, tooling and development of parts and components[12]. Unlike previous programs, Boeing let suppliers perform necessary tests in their own labs for the components they produce before integrating them at Boeing's facilities (FAA, 2014). In the case of 777, its previous program before 787, every system was tested simultaneously in a single systems integration lab of Boeing (Condit,

---

[11]One major motivation of Boeing was the MD-95 outsourcing model which kept development costs substantially low for McDonnell Douglas (Wagner and Norris, 2009)
[12] "Boeing Establishes 7E7 Council" Boeing New Release, October 8, 2003

1994). The aim was to assemble a 787 in only three days after the arrival of completed parts to the final assembly line after an initial ramp-up period with as few employees as possible, counted only in hundreds compared to thousands needed to produce previous models with up to several weeks needed for each aircraft (Wagner and Norris, 2009). Besides extensive outsourcing, the company divested its Kansas and Oklahoma commercial aircraft divisions that were initially assigned to produce aerostructures of 787. Built its capabilities on Boeing's previous assets and resources, Spirit AeroSystems emerged quickly as the biggest aerostructures manufacturer in the world after it received important 787 as well as A350 work. In a short time, it opened up new aerostructure facilities or bought other companies in the US and in Europe.

According to the estimates Boeing outsourced more than 70% of the development and production of 787 to several hundred firms all around the world. The greater responsibility assigned allowed suppliers to own their intellectual property gained through their R&D efforts (Tang and Zimmerman, 2009).

Subsequently Boeing encountered several problems during the development of the aircraft, and it had to delay its first delivery for more than three years with billions of dollars of cost overrun. The new method of product development based on an ill-structured supply chain organization with heavy and early outsourcing caused various design, development and assembly defects, parts shortage, erroneous component and subsystems testing and other technical challenges that might not occur under a well-defined product development process[13]. Boeing's insistence on reducing costs of development as well as management of the program, according to some estimates doubled the total costs of the aircraft including buying back some assets from its suppliers including a $1 billion plant producing aft fuselage of the aircraft[14]. Even after several years of product launch, a large number of Boeing employees is onsite at some suppliers helping them to solve development and production related issues (FAA, 2014).

[13]The delay of 787 and other problems occurred after deliveries started deserve a detailed discussion which is linked to Boeing's systems integration mismanagement but here only the major reasons of delays are highlighted. For a detailed list of 787 delays and their technical and organizational reasons, see Zhao, 2012

[14] "Boeing celebrates 787 delivery as program's costs top $32 billion", Dominic Gates, Seattle Times, September 24, 2011

One last issue with the 787 is the impact of program accounting practice on the profitability of the company, a matter which has been widely discussed by industry analysts and business press questioning whether the 787 program will ever be profitable[15]. The deferred accounting system spreads the development costs of a new program across an accounting block of a certain number of aircraft and eases the pressure on company's balance sheet. As an example:

> *If Boeing reported individual losses on the 114 787s delivered in 2014 based on the discrete costs of building each aircraft, the commercial aircraft division would have reported an overall operating loss of $122 million last year. Instead, the practice of bringing forward average unit profits over a production run of 1,300 aircraft onto current deliveries helped the division post a $6.4 billion profit in 2014 instead*[16].

The practice has been questioned by the US Securities and Exchange Commission, although it has been utilized by US aerospace companies for decades to address this development costs problem and is fully compliant with Generally Accepted Accounting Principles of the US. In February 2016, the commission asked Boeing whether Boeing its income figures relied on too optimistic sales forecasts as part of an ongoing investigation.[17]

3.4.2 Development strategy of Airbus A350

In terms of strategies on supplier organization, Airbus has many commonalities with Boeing. When the company decided to introduce a new wide body to compete with Boeing 787, Airbus was already under heavy pressure due to substantially increased R&D costs and consecutive delays of its superjumbo A380 mostly originated from internal organizational problems[18]. Its first attempt to introduce an upgraded A330 received harsh criticism from customers and forced the company to offer a brand new design with new technologies aboard. Afterwards the company came with a new design, A350 XWB. With the new program, Airbus introduced a 'New Systems Policy' which aimed to receive components and systems at an earlier stage in the production cycle and with a greater degree of maturity, having already been tested by the

[15] "Will Boeing 787 ever break-even?", Javier Irastorza, theblogbyjavier.com, October 28, 2011; "Why Boeing Keeps Losing Money on Each 787 Dreamliner", Justin Bachman, Businessweek, October 22, 2014; "Boeing reports new cost increases on 787 programme", Stephen Trimble, Flightglobal, January 28, 2015; "Will 787 program ever show an overall profit? Analysts grow more skeptical", Dominic Gates, Seattle Times, October 17, 2015

[16] "Boeing reports new cost increases on 787 programme", Stephen Trimble, Flightglobal, January 28, 2015

[17] "Boeing to Face SEC Probe of Dreamliner and 747 Accounting", Robert Schmidt, Julie Johnsson and Matt Robinson, Bloomberg, February 11, 2016

[18] "The Airbus saga: Crossed wires and a multibillion-euro delay", Nicola Clark, International Herald Tribune, December 11, 2006

supplier (interview with A350 XWB programme director Didier Evrard, in Beauclair, 2007) even though many of the suppliers at the date of the program launch were not prepared materially and technically to be fully involved (Kechidi, 2008). To enable a solid cooperation from the beginning of the program, they were assigned same processes, methods and even toolsets to maintain stronger collaboration with Airbus and with other suppliers in their workpackages (d'Apollonia, 2010). Like Boeing, it also aimed to reduce the number of its suppliers and assign them more design and manufacturing work, although the degree of outsourcing has not been the same for each system. The 'focus on core' policy of the company foresees in-house sourcing when the work is especially key for architecture, integration and technology leadership (Doerfler et al., 2012). In this New Systems Policy model, not only design and development (at a stage when the system of component is not fully defined), but also initial testing and readiness for mass production are performed by supplier firms[19]. The aim is twofold. The first motivation is to shorten the flight test phase and receive certification by reducing risks related to potential supplier deficiencies before the introduction of the aircraft to the market and to avoid any costs related to potential delays. The second motivation is to ramp up production as quickly as possible through greater maturity of suppliers' parts in order to fulfill much higher pre-introduction orders of new aircraft models compared to previous aircraft programs. Cost reduction through a rapid moving down the learning curve is an essential element of manufacturing strategy of aerospace firms. Another element of cost reduction, similar to Boeing, was divestments which include assets related to the manufacturing of A350. Harmonized with its multi-year cost-cutting and restructuring program Power 8, Airbus attempted to sell several components, subassembly and aerostructure sites in France, Germany and the UK and managed to sell only two out of seven planned site sales between 2008 and 2009. Large-scale supplier involvement in development and manufacturing was also under strain. Suppliers were under great pressure to fulfil their promises on time, and they encountered delays. In addition, they were asked price cuts for their sales to Airbus as part of the Power 8 program in order to share more of their productivity gains with Airbus. Learning from the mistakes of its earlier development program A380 and

[19] Tier 1 suppliers are selected according to their overall capability, including performance, cost and weight objectives and the ability to meet commitments. Following the selection, the supplier enters the Joint Definition Phase (JDP) where teams work together on a common design over a six-to-nine month period. After this period of close collaboration, individual partner companies can pursue development work at their home facilities, delivering their equipment two years later for bench testing (Beauclair, 2007).

continuing problems with Boeing 787[20], Airbus established a close coordination with its suppliers and tried to solve problems on site before the subassemblies were delivered to the final assembly line. Despite such efforts, the program encountered a delay of one and a half years before the company finally delivered the first aircraft in December 2014[21].

3.5 Supply Chain 787 vs. A350 - similarities more than differences

The Table 3.2 below shows the geographical distribution of 787 contracts in comparison with those of A350. In comparison to limited outsourcing of A350 out of Europe, Japan and North America (traditional centers of aerospace), Boeing created a much more extended network of suppliers leveraging its previous civil and military collaborations as well as brand new partnerships even though the contracts it signed with domestic firms represent the majority of 787 work. US firms are still important suppliers of Airbus. 43 percent of A350 contracts signed with US firms, only 17 percent of Boeing 787 contracts signed with four Airbus home countries. Concerning the direct procurement by OEM, more than half of these contracts are assigned directly by Airbus (148 contracts out of 268) and Boeing (204 contracts out of 397). The rest of the contracts are signed between first-tier and sub-tier suppliers. Around 10% of the contracts are assigned to jet engine suppliers and their contractors in both cases. Because several contracts are sometimes assigned to the same supplier, the total number of suppliers are less than the number of contracts. In the case of Boeing 787, this number is equal to 325 suppliers from 22 different countries. For Airbus it is 222 suppliers from 23 different countries. Beside these contractors, a number of joint ventures in China and Russia for both companies plus Malaysia for Boeing are particularly involved in 787 and A350 networks.

[20] "To Avoid Delay, Airbus Drops Lithium-Ion Batteries", Christopher Drew, Nicola Clark, The New York Times, February 15, 2013
[21] "Premier retard officiel pour le lancement de l'Airbus A350", Bruno Trevidic, Les Echos, November 15, 2010; "Reality Bites; Airbus delays A350-900 entry into service and terminates A340 production", Jens Flottau, Aviation Week & Space Technology, Volume 173, Issue 40, November 14, 2011; "EADS announces delay to Airbus A350", Andrew Parker, Financial Times, July 27, 2012

Table 3.2: Geographical distribution of Airbus A350 and Boeing 787 outsourcing contracts

Countries	Boeing 787	Airbus A350
USA	**255**	**115**
UK	30	47
France	19	30
Germany	13	22
Spain	5	11
Airbus home countries	**67**	**110**
Japan	13	6
Italy	7	5
Canada	14	2
Austria	5	6
Belgium	3	5
Czech Republic	0	1
Denmark	0	1
Greece	1	0
Netherlands	5	3
Poland	0	1
Russia	0	1
Sweden	4	4
Switzerland	1	2
Turkey	1	1
China	2	1
India	3	0
Israel	7	0
Malaysia	2	1
South Korea	4	1
Taiwan	1	0
Thailand	1	0
UAE	1	1
South Africa	0	1
Total number of contracts	**397**	**268**

Source: Airframer + author's collection through company news releases and company web sites. The lists do not represent the entire supply chain of each program although the biggest workpackages in terms of contract value and technological content together with their major suppliers are all represented

Even though the great majority of suppliers are fully or largely positioned in the aerospace business, there are quite a large number of specialized suppliers for both programs which have trans-industry capabilities, serving multiple industries with their products and services. Materials, machinery and electronics are the industries many of the Airbus and Boeing suppliers are actively present. Many suppliers are either the subsidiaries or business units of major industrial firms. Table 3.3a provides information on the organizational and ownership forms. While smaller contracts are generally signed with independent and mostly private firms, the majority of contracts are signed with subsidiaries or business units of large public or private firms. Table 3.3b shows the age distribution of contractor firms. Belonging to mature industries like aerospace, materials or machinery, around half of the contractors' parent firms are in business for more than half a century. In both cases average age of parent firms is above 60.

Table 3.3a: Organizational forms and ownership structures of Airbus A350 and Boeing 787 suppliers

Contractor's organizational form	**Boeing**	**Airbus**
Parent company	130	83
Joint venture	2	1
Subsidiary of a company	142	105
Unit of a company	50	33
Private Equity Investment	1	0
Total	**325**	**222**
Contractor's ownership form		
Public	26	23
Parent is public	146	99
Private	98	63
Parent is private	43	31
State-owned	5	2
Parent is state-owned	3	2
Employee-owned	2	1
Parent is employee-owned	1	0
Not-for-profit	1	1
Total	**325**	**222**

Source: Airframer + author's collection through company news releases and company web sites

Table 3.3b: Age distribution of the parent firms of Airbus A350 and Boeing 787 suppliers

Year of inception of parent firms	**Boeing**	**Airbus**
before 1901	26	27
1901-1920	18	15
1921-1940	19	13
1941-1960	52	32
1961-1980	48	27
1981-2000	59	49
after 2001	11	13
unknown	2	1
Total	**235**	**177**
Average age	**62**	**63**

Source: Airframer + author's collection through company news releases and company web sites

The geography of A350 and 787 parts manufacturing more or less represents a similar picture to the distribution of contractor firms' origins with some distinctions. Table 4.4 below provides locations of major design, development or manufacturing sites of the contracts signed. The technological and organizational dominance of US aircraft manufacturing is also highlighted even though the number of actual sites where the work is performed is smaller compared to the number of contracts signed with US firms. In many cases, the work is either performed in multiple locations in the US and Europe or directly by foreign companies' local subsidiaries. There is a considerable number of contracts geographically distributed across the world in terms of their realization. It reflects the increasingly global character of the design, development and manufacturing of commercial aircraft and parts. Low-cost arguments at least for bigger workpackages available in these lists are not valid. There are only a few low-cost production sites available including Mexico and Philippines which are two new manufacturing geographies for A350 and 787 work.

Table 3.4: Geographical distribution major sites for Airbus A350 and Boeing 787 contracts

Location of major design/development/ manufacturing site for the contract	**Boeing**	**Airbus**
USA	**228**	**83**
UK	20	44
France	15	24
Germany	10	17
Spain	4	10
Airbus home countries	**49**	**94**
Japan	11	5
Italy	7	5
Canada	7	2
Mexico	2	1
Austria	5	6
Belgium	3	5
Czech Republic	0	1
Denmark	0	1
Greece	1	0
Netherlands	5	2
Poland	0	1
Russia	0	1
Sweden	4	4
Switzerland	1	2
Turkey	1	1
China	2	3
India	3	0
Israel	7	0
Malaysia	2	1
South Korea	4	1
Taiwan	1	0
Thailand	1	0
UAE	1	1
Philippines	0	1
South Africa	0	1

US & France	0	1
US & UK	1	0
US & Canada	3	0
US & Mexico	2	0
multiple sites in Europe	4	3
multiple world locations	42	41
Total	**397**	**268**

Source: Airframer + author's collection through company news releases and company web sites

It has been widely discussed that Airbus and Boeing have decreased the number of contractors in their latest aircraft programs by outsourcing bigger workpackages to specific companies compared to smaller work attributed to multiple firms in their previous programs. It is actually not the size of the workpackages that matter. They have worked with big suppliers in their previous programs as well. What is different in their latest programs is the degree of completeness of the systems delivered Airbus and Boeing final production lines to be assembled. That is how they have managed to considerably reduce production lead times. And this model is simultaneously applied to their other models assisted with lean production techniques, substantially reducing the aircraft's final assembly time. It is beyond the scope of this study to conduct a detailed analysis of the capability dynamics of suppliers in a comprehensive way mostly due to lack of available data on the details of OEM-supplier relations such as clauses of contracts. One curious observation of the data collected, however, shows that around a quarter of A350 and Boeing 787 suppliers are working for both programs. This is a sign of the transfer of the experience gained in one program to the other one. Due to the chronological order, this is mostly through Boeing 787 towards Airbus A350. Considering the large number of US suppliers in both programs, it can be guessed that the main recipients of such cumulative capability enhancement are US firms. Next to historically important US engine and aircraft systems and parts suppliers like Pratt Whitney, GE Aviation or Honeywell, the development and production period of Boeing 787 and A350 witnessed a rapid growth of an important group of US aerospace suppliers like Rockwell Collins, UTC Aerospace Systems, Parker Aerospace, Moog, Hexcel and Ducommun which participate to both programs. US companies are leading partners of Airbus in the fuel, hydraulics and avionics systems on the A350 XWB program as they already gained substantial experience with newest technologies by their involvement in 787.

3.6 Insourcing 787 vs. 350 - differences more than similarities

In order to have a complete picture of supply chain organization, the outsourcing comparison should be complemented with the structure of insourcing of the same product in question. Beside in-house design and development of an aircraft, the size and complexity of the parts and components manufactured and assembled within the walls of company sites and plants including the final assembly line show the depth of key manufacturing skills and capabilities directly related to the resilience of the productive organization in the long-run capable of developing and manufacturing ever more innovative products in the future.

Table 3.5 shows the major parts and components of Boeing 787 and Airbus A350 produced in-house. Highly criticized by industry specialists, extensive outsourcing of Boeing 787 has been proposed as the major element of its systems integration model in which everything except final assembly can be outsourced. At the beginning of the program, except for some flat composite surfaces like vertical tail fins, trailing edge wing surfaces and a few airframe and engine assemblies like wing to body fairings and engine strut pylons, all other systems and components including wings, fuselage sections, nose and avionics and electronic systems were outsourced. Only after the company bought the operations of Vought producing aft fuselage sections in 2009 and further investments after 2011 to produce specific composite sections, its manufacturing share has slightly increased. Even after these investments domestic in-house production remained highly limited as most of the existing manufacturing is held in subsidiaries and units abroad.

On the contrary, Airbus continued to develop and manufacture major assemblies (wings, most of fuselage, nose and doors) and various other critical and non-critical sections predominantly in its domestic production sites. China is the only country where both companies' subsidiaries contribute to these programs. Other than outsourcing to Chinese origin firms and joint ventures, both companies strategically decided to allocate some manufacturing within China in exchange of potential orders by Chinese airlines.

Table 3.5a: Boeing 787 parts and components manufactured in-house

Company	Manufactured product categories	Ownership Type	Location of Major Design/ Development /Manufacturing site for the contract
BHA Aero Composite Parts Co., Ltd	Aircraft Control Surfaces: Trailing edge panels for vertical fin	Subsidiary	Tanggu District, Tianjin, China
Boeing Aerostructures Australia	Wing Flaps: Moveable trailing edge wing surfaces	Subsidiary	Melbourne, Australia
Boeing Canada Winnipeg Division	Fairings: Wing to body & vertical fin fairings; Aircraft Doors: Main landing gear doors	Unit	Winnipeg, Manitoba, Canada
Boeing Canada Winnipeg Division	Engine Pylons: Engine strut forward & aft pylons	Unit	Winnipeg, Manitoba, Canada
Boeing Fabrication Services	Wings: Vertical fin; moveable trailing edges; Fairings: Wing to body fairings	Unit	Auburn, Washington, USA
Boeing South Carolina	Fuselage Sections: Aft fuselage	Unit	North Charleston, South Carolina, USA
Boeing South Carolina & Boeing Everett	Final assembly	Unit	North Charleston, South Carolina & Everett, Washington, USA

Source: Airframer + author's collection through company news releases and company web sites

Table 3.5b: Airbus A350 XWB parts and components manufactured in-house

Company	**Manufactured product categories**	**Ownership Type**	**Location of Major Design/ Development /Manufacturing site for the contract**
Airbus Group Innovations	Research/Consulting Services: RHEA virtual reality design software	Unit	Suresnes, France & Ottobrunn, Germany
Airbus Deutschland GmbH	Wing Spars: Wing stringers	Subsidiary	multiple sites in Germany
Airbus Deutschland GmbH	Wings: Composite upper wing shells; Empennages: Vertical tailplane; Fuselage Sections: CFRP fuselage shells	Subsidiary	multiple sites in Germany
Airbus Helicopters Deutschland	Aircraft Doors: Passenger & cargo doors	Subsidiary	Donauwörth, Germany
Premium AEROTEC GmbH	Aircraft Flooring: Floor crossbars, floor structure in aft fuselage; Fuselage Sections: Sections 13/14 & 16/18; Aircraft Interior Bulkheads: Aft pressure bulkhead	Subsidiary	multiple sites in Germany
Premium AEROTEC GmbH	Aircraft Landing Gear: Main landing gear attachments	Subsidiary	Augsburg, Germany
PFW Aerospace AG	Metal Tubing: Fuel & bleed air tubing systems for wings & fuselage	Subsidiary	multiple sites in the world
Airbus UK	Wings: Wings	Subsidiary	multiple sites in the UK
Airbus UK	Testing Services: Landing gear systems testing	Subsidiary	Filton, UK
Alestis Aerospace SL	Fairings: Belly fairing	Subsidiary	Puerto de Santa Maria, Spain
Harbin Hafei Airbus Composite Manufacturing Centre	Fairings: Belly fairing parts; Aircraft Control Surfaces: Rudders, elevators; Aircraft Doors: Section 19 maintenance doors	Joint Venture	Harbin, China
Stelia Aerospace (Aerolia)	Nose Cones: Nose fuselage; Fuselage Sections: Mechanically milled 3D fuselage panels, composite fuselage panels	Subsidiary	Méaulte, France
Stelia Aerospace (Aerolia)	Hydraulic Systems & Equipment: Hydraulic & cabin systems tubes & pipes	Subsidiary	Méaulte, France
Stelia Aerospace (Sogerma)	Passenger Seating: "Equinox" premium seats	Subsidiary	multiple sites in the world
Stelia Aerospace (Sogerma)	Crew Seating: Cockpit seating	Subsidiary	multiple sites in the world
Cassidian SAS	Automated Test Equipment:	Subsidiary	multiple sites in France
Intespace	Environmental Test Equipment: Static test monitoring	Subsidiary	Toulouse, France
Airbus France	Final assembly	Subsidiary	Toulouse, France

Source: Airframer + author's collection through company news releases and company web sites

3.7 Capability development through knowledge acquisition

The systems integration orientations of and heavy outsourcing by both firms raise questions about their degrees of commitment to develop necessary technological and organizational capabilities configured around their business strategies. Cognitive human skills are the principal indispensable requisites to develop and deploy those capabilities for specific purposes like setting up a product development organization.

The widening gap between knowledge and manufacturing bases of large companies has attracted some interest of scholars of technology and innovation (Acha et al., 2007; Brusoni et al., 2001; Granstrand, et al., 1997). Risks related to outsourcing technological knowledge and innovation aroused interest in exploring the knowledge dynamics of firms outsourcing large sections of their product development and manufacturing efforts which have long been labelled as systems integrator firms. In order to keep up with rapid technological change, even though they resort to extensive outsourcing, these firms try to continue developing technological knowledge in-house in order to be able to coordinate their value chains and maintain their technological superiority, at least in terms of their knowledge base and systems integration capabilities (Brusoni et al., 2001; Granstrand, et al., 1997).

3.7.1 Boosting patent applications

The efforts to measure technological competencies of firms have popularized the micro-level work on patents. Patents supposedly signify that the holder has the competence to improve technology in a given field and patenting is a fairly operational and universal system of classification of corporate competencies in different technological fields (Granstrand, et al., 1997). Firms, especially large ones, have been building broader technology bases in order to explore and experiment with them for their potential deployment (Granstrand, et al., 1997; Kortum and Lerner, 1999). Strategy-related motivations and better innovation management practices have also helped firms to build large patent portfolios in the last decades (Hall and Ziedonis, 2001).

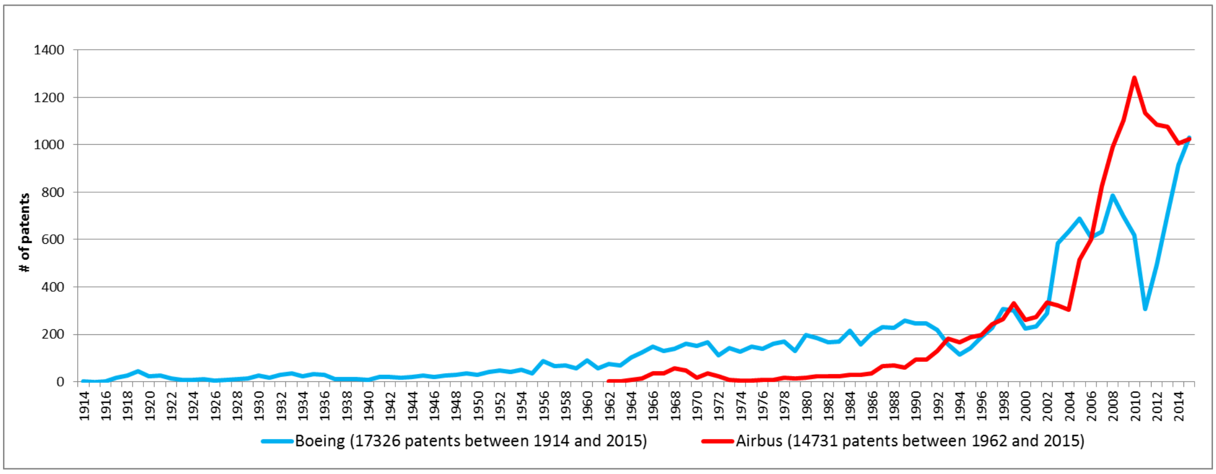
However, detecting the gap between knowledge base of companies and their manufacturing capabilities is not an easy job. The evidence is mainly documented through patent analysis of firms, and it is usually not complemented with further research on other qualitative and quantitative aspects of companies' investments in skills and technologies, the integration of those with ongoing development and manufacturing programs, and the impact of their broader business strategies on their innovative capabilities. Systems integration is mostly about concurrent organizing of design and production integration into the final product. The depth of knowledge of a systems integrator over the entire design and production process can only be estimated with the measure of the degree of involvement in research, development and manufacturing. To possess technological expertise in any part of productive activity, any theoretical knowledge documented through patents should be coupled with the knowledge over how to realize those technologies and integrate them into production process (Acha et al., 2007). If a technology is understood as 'the body of knowledge underlying the design, development, and manufacture of the product' (Prencipe, 2001) then a firm, in many of the cases, also needs to manufacture the product in order to have a complete understanding of the technology. Furthermore, exploiting technological opportunities is related to the degree of organizational capabilities of firms to cope with innovation challenges (Christensen and Rosenbloom, 1995; Granstrand, et al., 1997). That is, next to the capabilities related to knowledge accumulation and manufacturing, companies are required to have the necessary organizational capabilities to bring both internal and external knowledge and manufacturing skills together in order to sustain their innovative performance.

The B787 and A350 examples show that in order to sustain their long-run competitive advantage, OEMs have to maintain a delicate balance between their in-house and external capabilities. In-house capacity is required to meet technical performance requirements of advanced aerospace products. External capabilities developed by partners are also crucial as they can be superior or unreachable for systems integrators, and they have to rely on numerous other technologies developed outside their walls. Moreover, they have to possess the necessary organizational capabilities to establish a steady flow of information running in and out of the firm to guarantee product development. In some cases, any issue with the flow of information within the boundaries of the firm may also cause problems, as the A380 example has shown. These capabilities help them to maintain full control over innovation through accumulated knowledge, skills, experience, and the diffusion of control and authority to minimize related risks. In the systems integration business model as it is expressed in the latest programs of Airbus and Boeing, there is a focused capability development effort in commercial aircraft production which is extensive in knowledge but selective in application.

In effect both firms have been harnessing knowledge dispersed in different domains of technology and patenting them at an accelerated speed in the last three decades. The analysis of patent applications show that Airbus has been following an energetic strategy to publish more patents than Boeing in the last decade. These patents are especially concentrated in technological fields important for new aircraft designs. The gap between the two companied widens in specific technology classes within commercial technologies.

Figure 4.2 shows the number of patents issued by Boeing and Airbus as current assignees. These numbers also include non-commercial aircraft segments of the firms. The patents assigned to Airbus either before the inception of EADS in 1999 or Airbus Industrie in 1969 refer to those issued by predecessor companies of partners which formed Airbus in 1969. Mostly state-owned and defense related, these companies were not so willing to publish the results of their research at least until the early 1990s, when large scale privatization of aerospace and defense companies started all over Europe.

Figure 3.2: Number of patents issued by Boeing and Airbus as current assignees, 2015 included



Source: Questel Orbit patent search engine. To generate a complete number of patents issued by both firms, first, the necessary keyword adjustments on the list of subsidiaries of both companies available in the database were performed in order to extract the patents issued by right group of companies. Later, a certain number of patents omitted from the total numbers after a detailed check of assignees of each patent issued by both companies. As a result of the second adjustment, a total of 333 and 736 patents are omitted from the Airbus and Boeing lists respectively

The difference between the number of patents issued by parent companies during the development of A320 and A330/A340 programs and those numbers when Airbus worked on A380 and A350 programs is remarkable. After the foundation of EADS as a public company, since early 2000s, there has been a potent increase in patenting when the company focused on the development of its A380 and A350 programs. In addition, Airbus continued to heavily invest in other aerospace business segments, while Boeing completely left the commercial helicopter and turboprop aircraft businesses in the last two decades.

During the same period Boeing has also shown remarkable performance in patenting even though it was not as spectacular as Airbus until the last two years. The rise in the number of patents during the development period of the 787 remained limited and quickly disappeared after the aircraft was put into service in 2011. A very rapid increase in the number of issued patents in 2014 and 2015 helped company to catch up with Airbus. The two companies issued almost the same number of patents in 2015 (1030 for Boeing and 1024 for Airbus).

Figures 3.3a and 3.3b detail the number of patents issued by Airbus and Boeing in their top 15 patent groups in the last 30 years. These groups largely correspond to the commercial aircraft segments of the two companies, with the growth of patenting of Airbus increasing substantially over the last three decades. While there are specific domains in which Boeing is patenting more than Airbus such as digital computing, radio transmission, and semiconductor devices, in major commercial aircraft fields like fuselages, frames, wings, passenger or crew accommodation, and composites Airbus has been performing much stronger than Boeing in terms of knowledge generation within these fields. These are also the areas Boeing has largely outsourced in its latest program 787 while Airbus has kept these activities in-house. However, the relation between patenting and outsourcing in commercial aircraft manufacturing is not always linear. In avionics, one of the most technologically complicated fields in aerospace, Boeing patented as much as Airbus during the same period while it also outsourced some major elements within the field such as flight controls. In contrast, Airbus continued to develop in-house some of these technologies and it even insourced some elements of the avionics technology in its latest program. The company has a balanced strategy of avionics outsourcing and insourcing (Beaugency, Sakinc and Talbot, 2015).

Figure 3.3a: Growth in the number of patents issued by Airbus in top 15 patent groups between 1986 and 2015

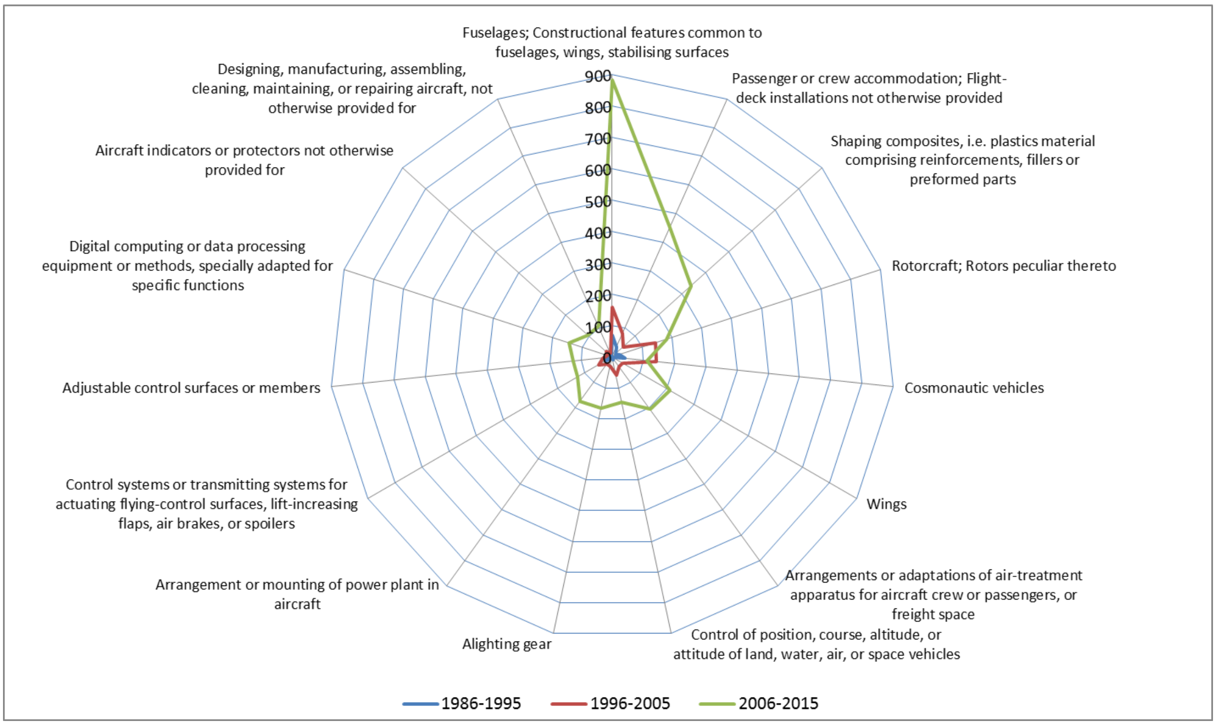
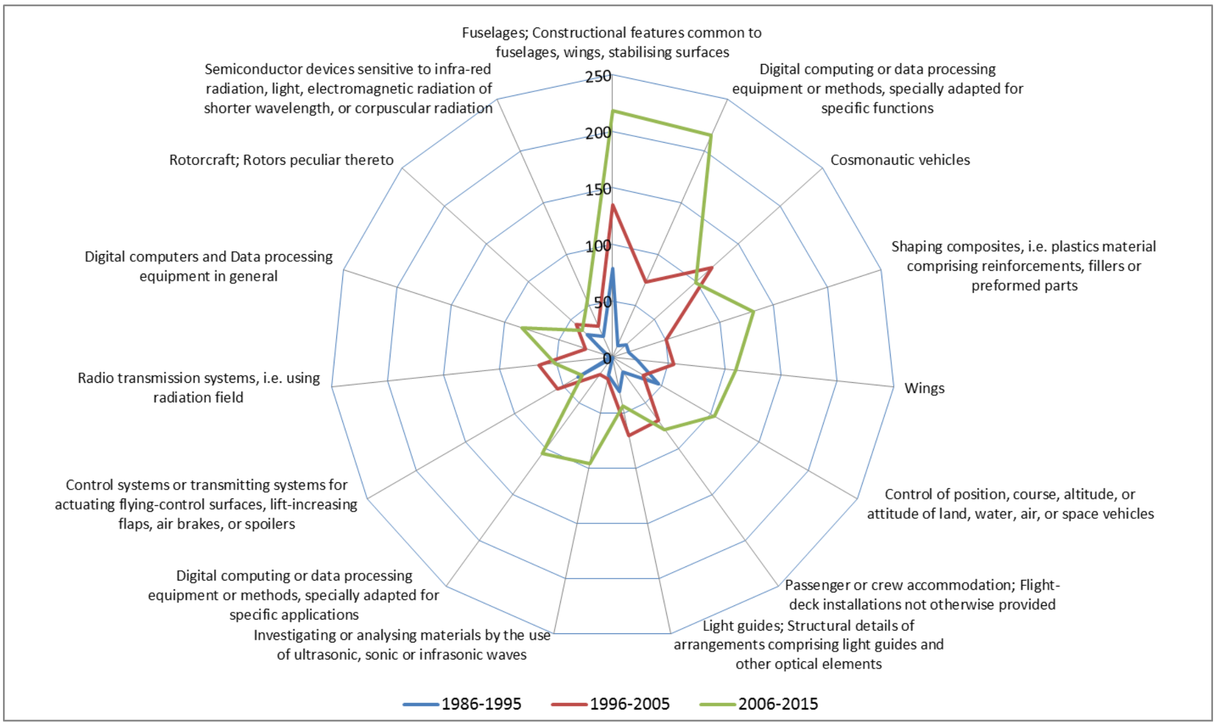


Figure 3.3b: Growth in the number of patents issued by Boeing in top 15 patent groups between 1986 and 2015



Source: Questel Orbit patent search engine

As stated, the difference of patenting performance in performing operations which are directly related to aircraft design and development is especially striking. Figure 3.4 below provides comparisons of the number of patents issued in four critical patent subclasses and groups related to commercial aircraft manufacturing. The first chart (4.4a) shows the number of patents issued each year in two major aircraft related subclasses namely B64C (Aeroplanes, Helicopters) and B64D (Equipment for Fitting in or to Aircraft; Flying Suits; Parachutes; Arrangements or Mounting of Power Plants or Propulsion Transmissions in Aircraft). The second (4.4b) and the third (4.4c) compare the number of patents in B64C-003 (Wings) and B29C-070 (Shaping composites, i.e. plastics material comprising reinforcements, fillers or preformed parts) subgroups respectively.

Figure 3.4a: Number of patents issued by Boeing and Airbus as current assignees in B64C and B64D subclasses combined between 1964 and 2015

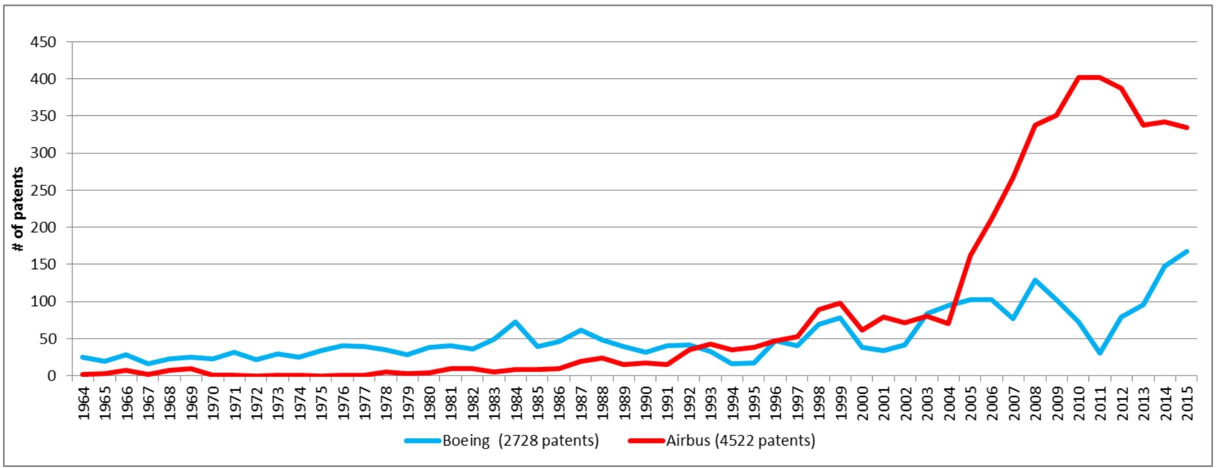


Figure 3.4b: Number of patents issued by Boeing and Airbus as current assignees in B64C-003 Wings patent group between 1990 and 2015

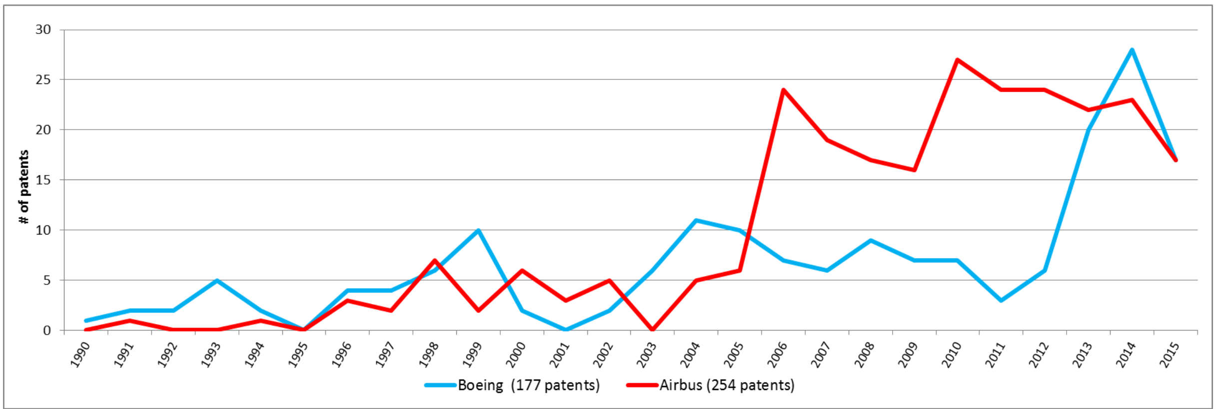
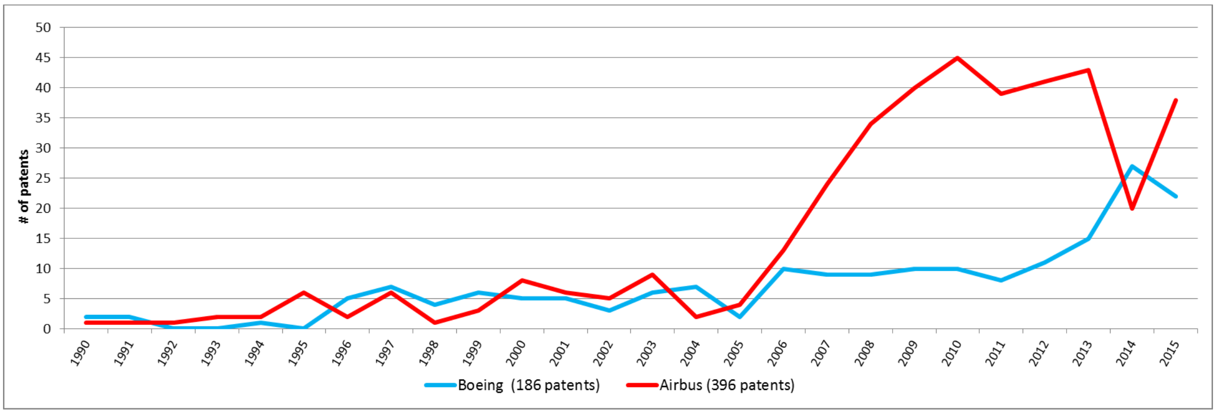


Figure 3.4c: Number of patents issued by Boeing and Airbus as current assignees in B29C-070 Shaping composites, i.e. plastics material comprising reinforcements, fillers or preformed parts patent group between 1990 and 2015



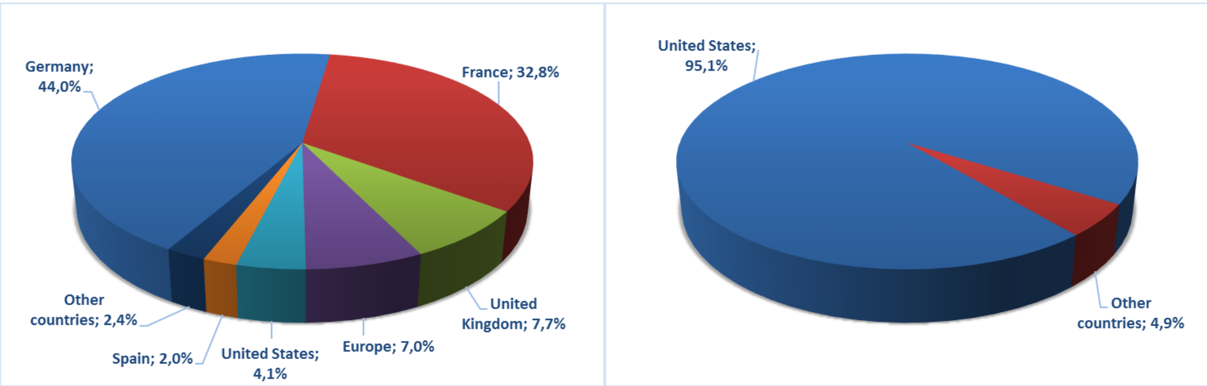
Source: Questel Orbit patent search engine

While the early literature on patents claims that there is no clear association between technology diversification and product diversification (Brusoni et al., 2001; Granstrand, et al., 1997), the statistics show a certain degree of relation between the number of inputs (patents) provided by the two companies and the degree of outsourcing in their latest programs. Extensive outsourcing of Boeing 787 including its wings and most of its aerostructure (fuselages, stabilizers, tail, etc.) is expressed in the low level of patent applications in related fields during its development period which spans the period between 2003 and 2011. In contrast, during the period between 2006 and 2014 when Airbus designed and developed its A350 XWB and kept most of the development of those structures and components in-house, a big surge in patent applications is observed.

If the low level of patenting in 2000s can be explained by the high level of outsourcing, what is the reason behind Boeing's most recent surge in patenting? An answer can be found in the upgrading of two old models which are largely insourced compared to the 787. The upgrades, 737 MAX and 777X, have been under development since 2012 and 2014 respectively and the significant improvements are to the wing for both programs, the interface of the wing and the engine, the use of winglets (737 MAX), and folding wingtips (777X). Boeing's decision to bring 777X wings in-house is a clear indication of the desire to be able to continue component manufacturing. It might have had systems integration knowledge about composite wings, but it does not know how to manufacture them. It is most probable that the high level of patenting in specific fields like wings or composites will sustain during the development of the 777X for a couple of years or more. There is a question mark in the case of Airbus which currently has two upgrading programs A330neo wide-body and A320neo while A320neo upgrading is close to completion. Except composites which have a much wider application, that is they are not only specific to airframes, there has been a continuous decrease in aircraft patenting since the early development period of A350.

In the last part of the patent discussion some information can be provided on the geography of patenting activity of the two firms. Unsurprisingly a great majority of patents are produced in their home countries. Figure 3.5 shows that 94 percent of Airbus patents and 95 percent of Boeing patents are produced in their home countries. Apparently the locations of research and development labs and centers of two companies and the prominent role of home-country public R&D are possible explanations of the 'homebound' nature of industrial patenting (Mowery, 2009). Germany is the leading country of Airbus in terms of knowledge generation.

Figure 3.5: Priority country distribution of the patents issued by Airbus and Boeing



Source: Questel Orbit patent search engine

The literature on the sources and impact of innovation utilizes patents as information providing outputs of innovative activities with certain limitations when they are aggregated as indicators of innovation (OECD, 2001). However, patents should rather be conceptualized as an input to the innovation process, rather than an output (Mowery, 2009) especially in manufacturing activities where patenting on product innovation is mostly about product design and development. Moreover, limitations such as the highly variable economic and technological value of patents, their skewed distribution, and the close links between patenting activity and institutional structure such as laws and regulations regarding patents (OECD, 2001) make it difficult to make industrial comparisons from a historical perspective.

The quasi absence of patenting activity of Airbus for more than 20 years after it was founded in late 1960s is an example.

Creating this input necessitates an appropriate knowledge base reinforced with required investments in knowledge, skills and infrastructure. Thus for an inquiry into the degree of knowledge depth and the capabilities to transform these resources into final products, it is necessary to measure how much these companies actually spend on new product development. Two main items of measurement are related capital expenditures and R&D expenses.

3.7.2 Research and Development Costs

In the commercial aircraft sector, R&D expenditures and capital investments rapidly increase with a new aircraft development program and then gradually decrease when the program gets closer to completion. The extent of the program in terms of its technological sophistication, infrastructural requirements and the participation of program partners in development costs determine the size of expenditures for the parent firm. Figure 3.6 and 3.7 show commercial segments and total R&D expenditures of Boeing and Airbus and their proportions of commercial and total sales in the last two decades[22]. The monetary amount of resources allocated by OEMs and their partners substantially increased in line with the increase in technological complexity and tightening regulations required to produce safer and higher quality aircraft. Even though outsourcing might help to control their R&D spending in their latest programs, given the requirements to integrate an increasing number of technological fields (Granstrand, et al., 1997), their R&D levels are rather expected to increase. After a swift decline at the end of the development of 777, R&D expenditures of Boeing have risen once again along with the B787 R&D program which cost Boeing a minimum of $12 billion despite early plans to spend as little as $5.8 billion[23] to develop the airplane mostly due to missteps of

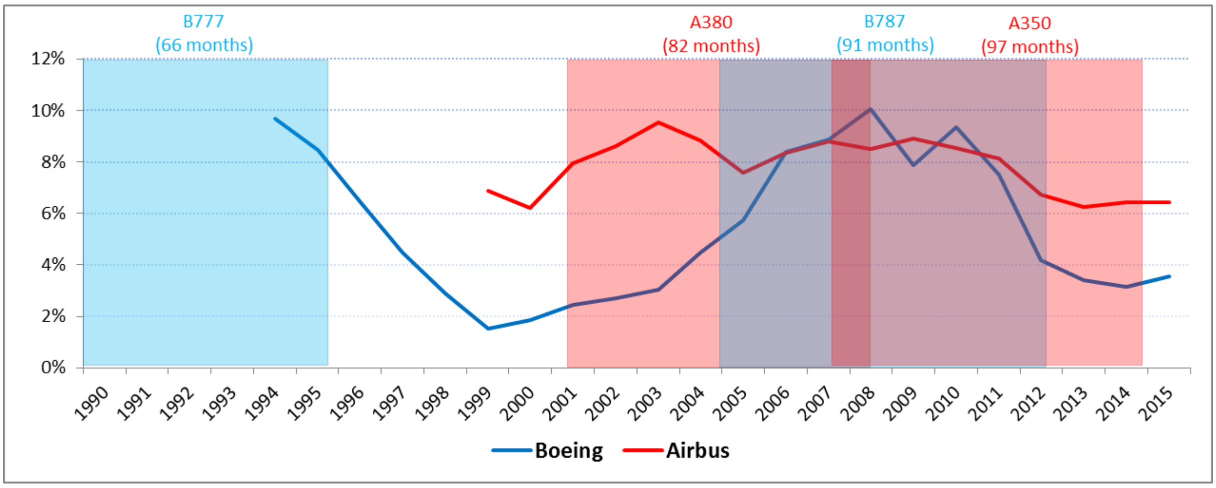
[22] Boeing started to publish segmented R&D figures only in 1994 and Airbus data is available starting with 1999. The difference between commercial aircraft segment and total reflects higher R&D spending of Boeing on military products. Between 2000 and 2015, Boeing devoted 64% of its total R&D on commercial aircraft programs while this ratio reaches 80% for Airbus.

[23] The low level of projected spending reflects cost sharing agreements with some of Boeing suppliers. These agreements make suppliers fund their own development expenditures as well as reimburse Boeing for its experimentation, basic design and testing activities during the 787 development. These payments are recorded as a reduction to Boeing's research and development expenses. Similar agreements also apply to Airbus.

the company[24]. After a steep increase during the development of the 787, total and commercial segment R&D expenditures of Boeing decreased quickly after 2011 even though there has been a recent surge in expenditures due to the investments on 737 MAX and 777X. In contrast, R&D expenditures of Airbus were mostly stable and but usually higher than Boeing's while they were only slightly increased during the years the company developed its wide-body airplanes, A380 and A350. The decrease in the last years is primarily due to the appreciation of the US dollar against the euro.

Beside new programs, upgrades of existing programs or new derivatives also contribute R&D costs of two firms. As of 2016 both firms have only derivative or upgrade programs leaving them without any planned aircraft program for the coming years. At present, Airbus is upgrading its A320 and A330 models with A320neo and A330neo and it continue to develop A350-1000 model of its newest aircraft program A350XWB. After completing its work on 787-9 version of its newest program 787 Dreamliner, Boeing is working on 737 MAX and 777X as upgrades of its existing models and the new 787-10 which is the extended version of 787.

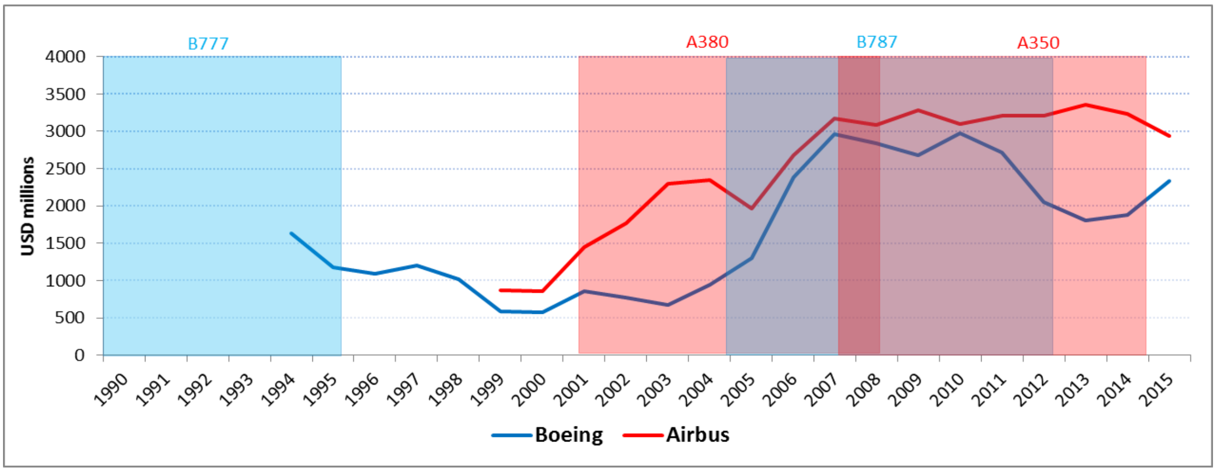
Figure 3.6a: Research and Development Expenditures of Boeing and Airbus in the commercial aircraft segment as a proportion of commercial aircraft sales



Months in parenthesis indicate the length of the development period represented with red and blue columns starting with the launch of the program until the delivery of the first aircraft.
Source: Company annual reports.

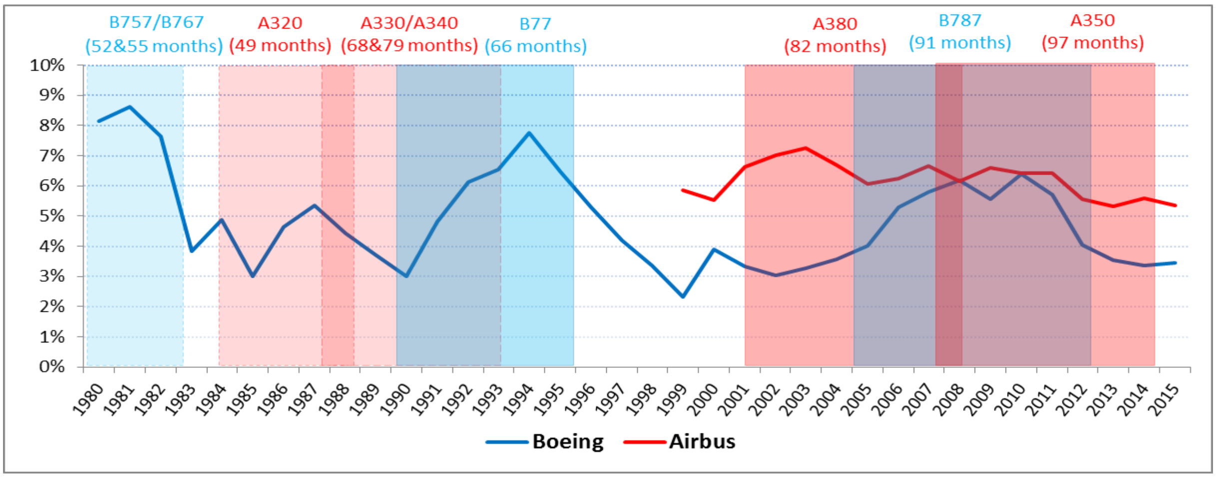
[24] "Boeing celebrates 787 delivery as program's costs top $32 billion", Dominic Gates, Seattle Times, September 24, 2011

Figure 3.6b: Total Research and Development Expenditures of Boeing and Airbus in the commercial aircraft segment, in current US$



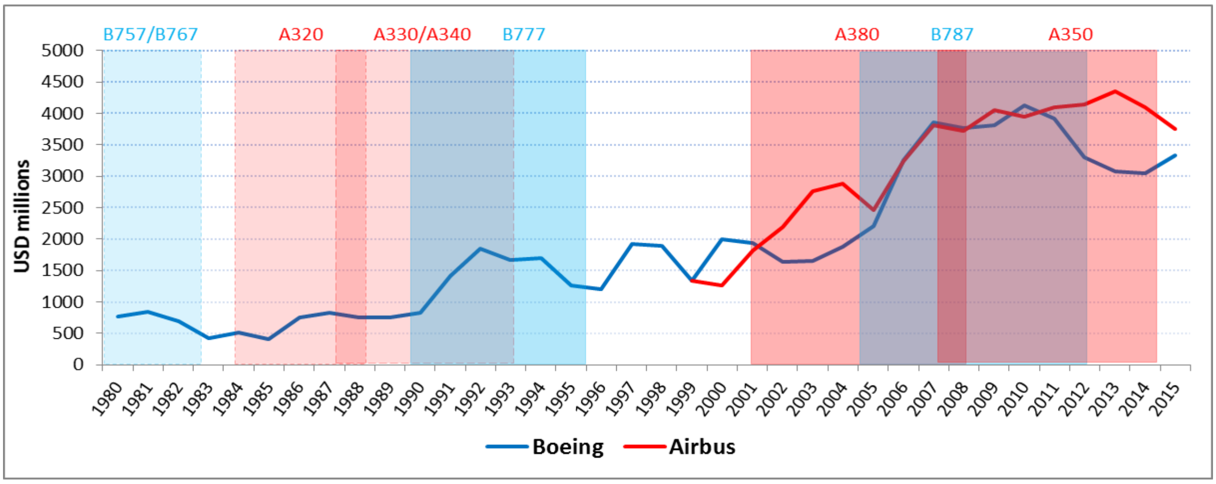
Source: Company annual reports. For Airbus yearly average exchange rates are utilized.

Figure 3.7a: Total Research and Development Expenditures of Boeing and Airbus as a proportion to total sales



Source: Company annual reports.

Figure 3.7b: Total R&D Expenditures of Boeing and Airbus, in current US$



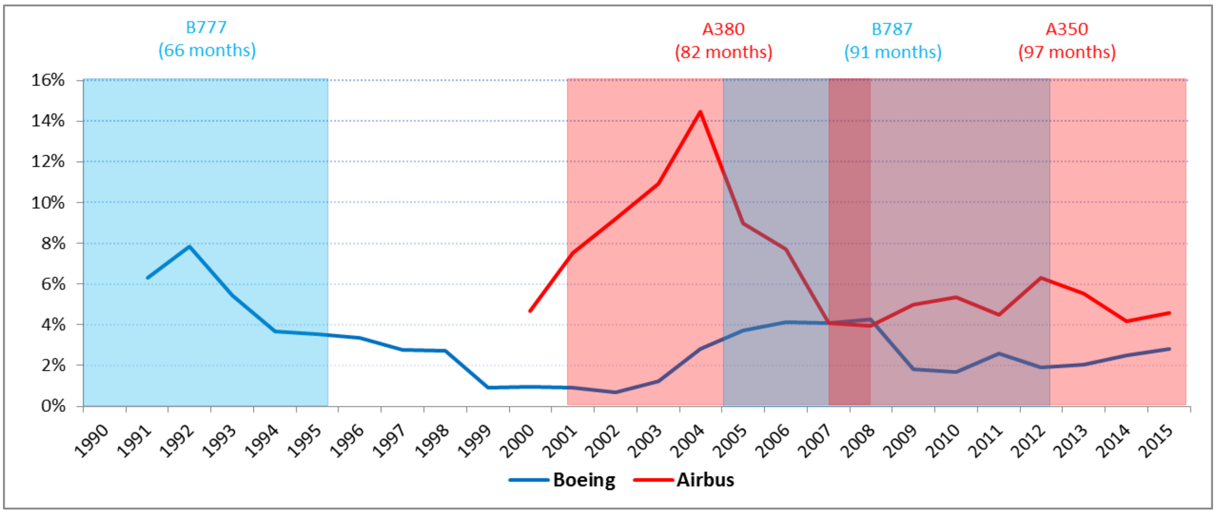
Source: Company annual reports. For Airbus yearly average exchange rates are utilized.

3.7.3 Capital Expenditures

Aerospace companies have to mobilize substantial amounts of financial resources for their spending on new machinery, tooling and new assembly lines or manufacturing plants as well. Details on the expenditures on new production sites, engineering centers, assembly lines and advanced machinery provide valuable information on growth strategies regarding the projected market share and value-added amounts, and the extent of desired capabilities in specific fields of aircraft manufacturing. The degree of financial commitment is tightly connected to the allocation of funds for material utilization through the links between investment strategies and long-term commitment of finance to innovation. Through new sites, centers and production lines, an OEM demonstrates its commitment to both product and process innovation and learning capacity of its workforce who will utilize their productive capabilities with advanced machinery tools and techniques together with required training.

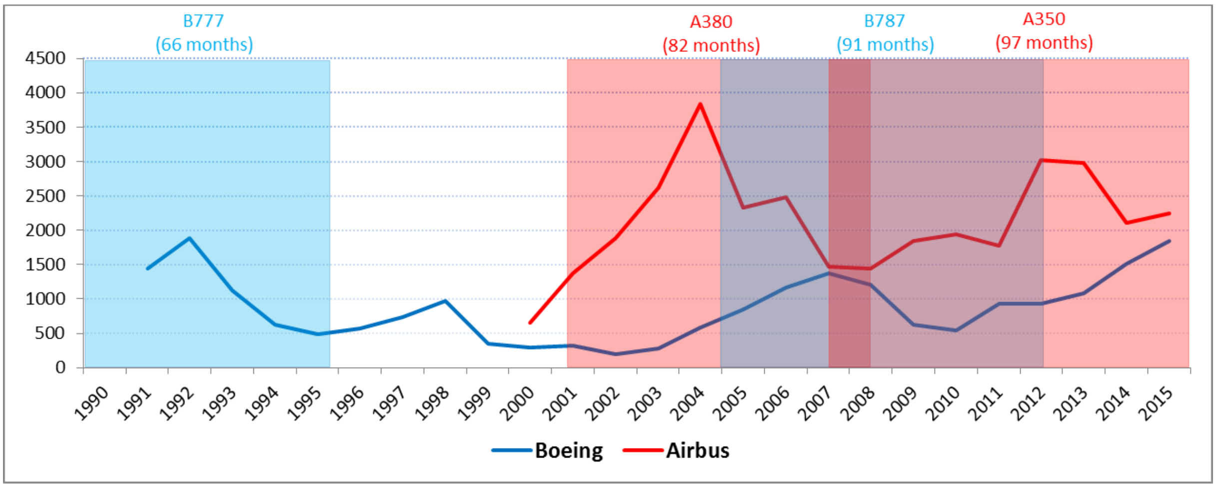
Figure 3.8 provides a comparison of commercial aircraft segment capital expenditures of Boeing and Airbus in the last two decades. The rapid increase in capital expenditures in their earlier programs of B777 and A380 has not been replicated in their latest programs B787 and A350 because activities are outsourced at unprecedented levels. The increase in capital expenditures of Boeing during the development of B787 stayed particularly minimal. The acquisition of several operations of 787 subcontractors in the US in 2008 and 2009 represents a forced capital investment for Boeing as a response to mounting 787 supply problems that contributed to the delay of the aircraft. In the period after 2011, the company continued to spend on capital investment in the form of new production and R&D centers that helped it to keep the level of capital expenditures stable. Compared to Boeing, investment strategy of Airbus is more diversified both geographically and segmentally. In the last fifteen years Airbus spent twice as much as Boeing on plant, property and equipment while it ran two new commercial aircraft programs compared to a single one by Boeing.

Figure 3.8a: Capital Expenditures of Boeing and Airbus in the commercial aircraft segment as proportion to commercial aircraft sales



Source: Company annual reports. Unallocated capital expenditures, which are substantially higher in the case of Boeing, are distributed to each segment according to their relative weight as a proportion to total allocated capital expenditures

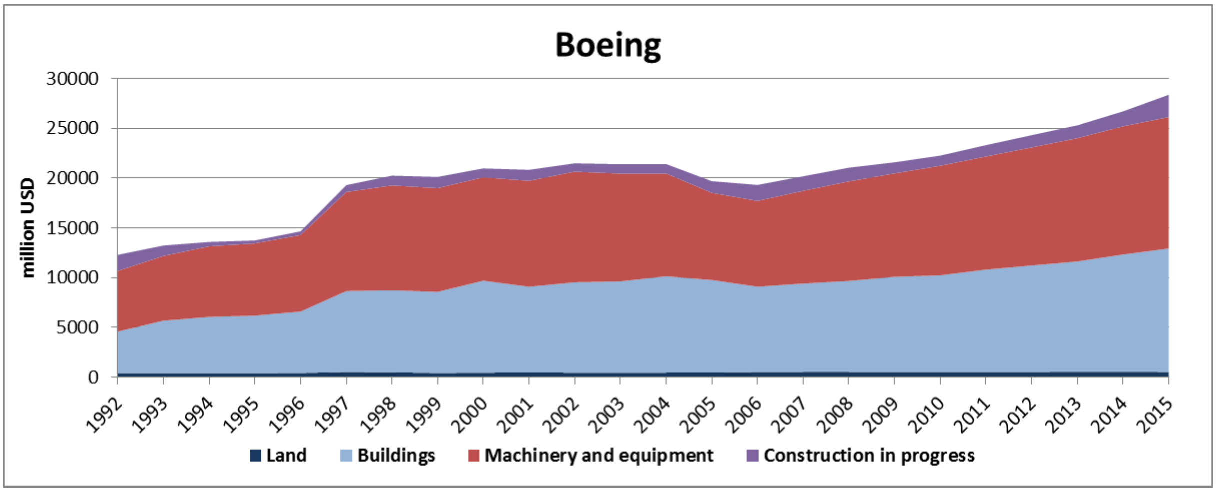
Figure 3.8b: Total Capital Expenditures of Boeing and Airbus in the commercial aircraft segment, in current US$



Source: Company annual reports. For Airbus yearly average exchange rates are utilized

To go into detail, a setback in Boeing's capital expenditures and a decline in real terms can be observed since late 1990s. Figures 3.9a and 3.9b show that Airbus' investment on new machinery and equipment is far larger than that of Boeing. Between 2000 and 2015, Airbus increased its investment on new technical equipment and machinery from €3.3 billion to €20.3 billion (or from $3.1 billion to $22 billion in US dollar terms) compared to around 25% increase of Boeing during the same period from $10.4 billion to $13.2 billion in current US dollars. One explanation offered was the lower level of investments of Boeing into the new generation of tools and equipment which Airbus was heavily investing in the late 1990s and early 2000s for its new programs (MacPherson and Pritchard, 2003)[25]. The access of Boeing to NASA and Department of Defense facilities and equipment through its research and development contracts may also explain its low level of investment in equipment (US Congress, 1991). In addition, in its latest program, Airbus' investment in new technologies exceeded Boeing's similar investments because the extent of outsourcing parts utilizing composite technology, new materials, and electronics is much higher in the case of Boeing compared to Airbus. The spending of Boeing on land and new buildings also remained very low compared to Airbus. Boeing's floor space numbers in Figure 3.10 show that since 2000, the company shrank close to 30% in terms of physical space through divestments and closure of production sites. Airbus does not publish floor space information on its land and building.

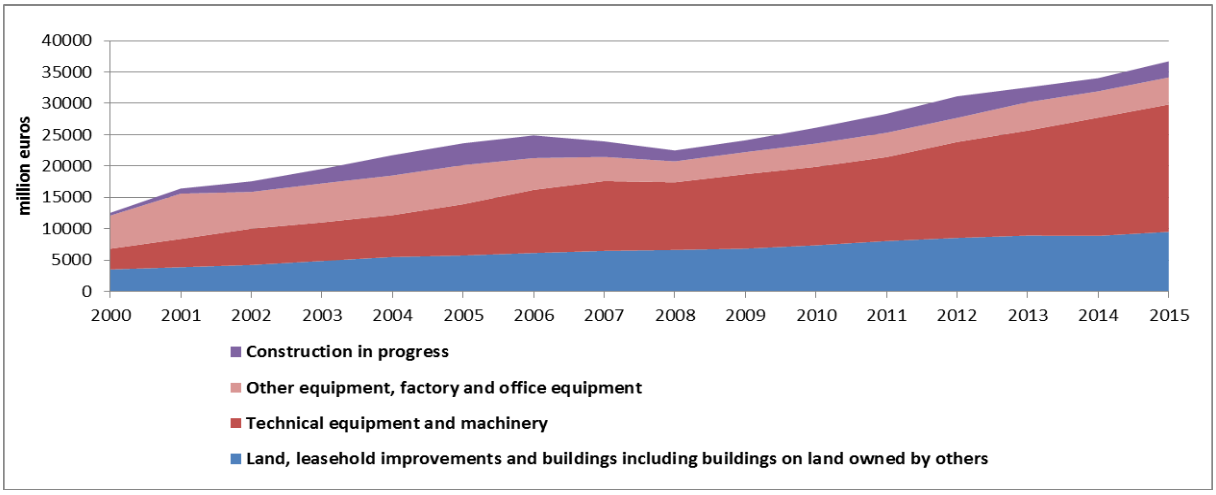
Figure 3.9a: Gross Plant, Property and Equipment Expenditures of Boeing, current US$



Source: Company annual reports

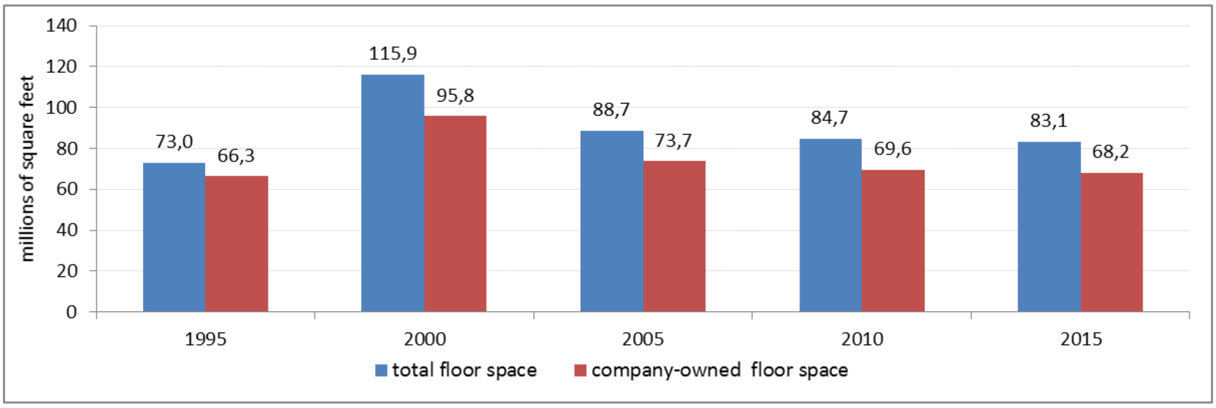
[25] Pritchard (2002) provides a discussion of aircraft assembly technologies utilized by Airbus and Boeing and conclude that the passage of Airbus to newer assembly technologies was prompt and extended especially due to incessant introduction of new models in the 1990s and 2000s.

Figure 3.9b: Gross Plant, Property and Equipment Expenditures of Airbus, current euros



Source: Company annual reports

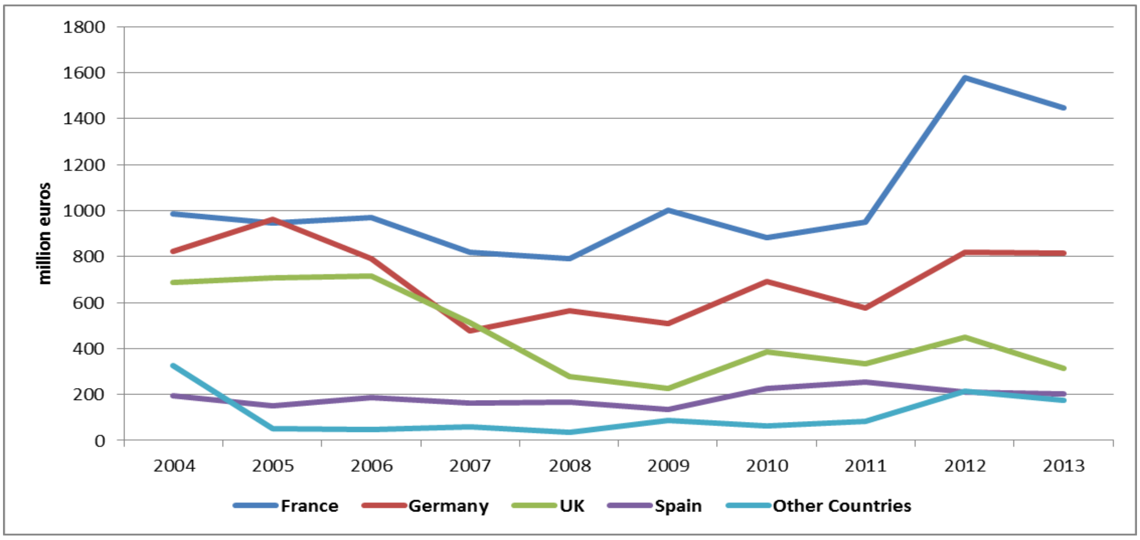
Figure 3.10: Floor Space of Boeing from 1995 to 2015



Source: Company annual reports. The substantial increase between 1995 and 2000 reflects Boeing's major acquisitions including McDonnell Douglas and Rockwell Aerospace during the period.

Another aspect to discuss is the degree of commitment of Airbus and Boeing in investing productive capabilities in their home countries. While Boeing does not publish data on geographical distribution of its capital expenditures, in 2015, 96% of its floor space was located in the US and its capital investment has been largely concentrated in its home country. Represented in Figure 3.11, Airbus published its capital expenditure figures per country between 2004 and 2013 and the most striking developments are the rise of expenditures in France which basically reflects the investments in the A350 assembly line and the considerable decrease in spending in the UK quickly following the exit of BAE from Airbus as a strategic partner and major shareholder. While the fall in investment in other countries at the beginning of the period following the rapid decrease in expenditures related to A380 superjumbo reversed upward with A350XWB and other investments, the low level of investment persisted for the UK, also related to divestment of some commercial aircraft production units within the country. The company stopped publishing details about geographical distribution of its capital expenditures since 2013.

Figure 3.11: Airbus Total Capital Expenditures by country



Source: Company annual reports

Since late 1990s, there has been a widening gap between the investments done by Airbus and Boeing. Table 3.6 summarizes major investments of Airbus and Boeing since 2000 with specific details on their technical and segmental categories, geographical distribution and value if provided. Airbus' investments are generally much greater in monetary values and represent broad-scale facilities as first-time investments including new final assembly lines. Moreover, Airbus' investments are geographically more diverse both for commercial aircraft and other segments. Out of a total of 40 major capital investments since 2000, the biggest number of investments was on commercial aircraft divisions (22) and Eurocopter (10 - today Airbus Helicopters) and more than half of these investments are located out of Airbus home countries. During the period, the company opened 10 engineering, research and technology centers and six of them are located outside of Europe. All of these investments are active or in construction as of early 2016.

During the same period capital investments of Boeing remained limited at least until 2015. In the first half of 2000s the company divested several of its new investments and only with 2010s, the company made several important investments including those for 787. It opened several research and technology centers within or outside the US but mostly inside, in line with the restructuring of its research organization. As part of its plan to reduce the weight of Washington State in commercial aircraft research and engineering, the company made several investments in the last two years in other states. Several production sites for commercial aircraft parts including for new programs like 777X show the efforts of the company to keep in-house manufacturing capabilities related to advanced technologies. Another difference with Airbus is that Boeing mainly resorted to expansions of existing sites and capabilities while Airbus opens up completely new sites as a result of its superior geographical and segmental expansion.

Table 3.6a: Major Investments of Airbus between 2000 and 2015

Year of Completion	Type of investment	Core activity of the investment	Location City	Location Country	Initial cost of investment (in millions)	Subsidiary (in the year of investment)	Division (in the year of investment)	Current situation	Part of an existing facility?
2000	Assembly facility	TBM series single-engine turboprop light business and utility aircraft	Tarbes	France	n/a	EADS Socata	Aeronautics	Active with reduced ownership	Yes
2002	Design & Engineering ctr	Design and engineering work for new commercial aircraft models	Wichita KS	USA	n/a	Airbus SAS	Airbus	Active	First invest.
2002	Production center	Propulsion systems for the European launcher Ariane	Ottobrunn	Germany	€ 20	Astrium Space Infr.	Space	Active	Yes
2003	Production center	A380 wing manufacturing	Broughton	UK	£73	Airbus SAS	Airbus	Active	Yes
2003	Assembly facility	A380 sections structural assembly	Hamburg	Germany	n/a	Airbus SAS	Airbus	Active	Yes
2003	Assembly facility	A380 wing assembly	Broughton	UK	£350	Airbus SAS	Airbus	Active	Yes
2004	Assembly facility	Final assembly and flight-testing of A-Star helicopter series	Columbus MS	USA	$11	American Eurocopter	Aeronautics	Active	First invest.
2004	Final Assembly facility	A380 FAL	Toulouse	France	n/a	Airbus SAS	Airbus	Active	First invest.
2004	Transport vehicle	Transport of A380 sections by sea	n/a	Europe	$30	Airbus SAS	Airbus	Active	First invest.
2005	Engineering center	Specific design work for the A350	Beijing	China	n/a	Airbus SAS	Airbus	Active as a JV	First invest.
2006	R&T center	Joint projects with Singaporean Research Institutions and Universities	Singapore	Singapore	n/a	-	-	Active	First invest.
2006	MRO center	MRO services for Eurocopter helicopters in Russia	Moscow	Russia	n/a	Eurocopter Vostok	Eurocopter	Active	First invest.
2006	Production center	Assembly plant for A400M wings	Filton	UK	€ 100	Airbus UK	Airbus	Active	First invest.
2006	MRO center	MRO services for Eurocopter helicopters in Malaysia	Subang	Malaysia	n/a	Eurocopter Malaysia	Eurocopter	Active	Yes
2007	Engineering center	A350 XWB interior design and definition work	Mobile AL	USA	n/a	EADS North America Inc	Airbus	Active	First invest.
2007	Production center	EC135, NH90, and Tiger FAL	Albacete	Spain	€ 60	Eurocopter	Eurocopter	Active	First invest.
2007	Assembly facility	Eurocopter MRH-90 assembly line	Brisbane	Australia	n/a	Australian Aerospace	Eurocopter	Active	Yes
2008	Transport vehicle	Transport of A380 sections by sea	n/a	Europe	n/a	Airbus SAS	Airbus	Active	First invest.
2008	Final Assembly facility	A400M FAL	Seville	Spain	n/a	Airbus SAS	Airbus Military	Active	Yes
2008	Final Assembly facility	A320 FAL	Tianjin	China	n/a	Airbus SAS	Airbus	Active	JV invest.
2009	Machinery	Autoclaves for the production of A350 forward fuselage sections	Nordenham	Germany	€ 6	Premium AEROTEC	Airbus	Active	First invest.
2009	MRO center	MRO for C-212 and CN-235 tactical transports	Mobile AL	USA	n/a	EADS North America Inc	Airbus Military	Active	Yes
2009	R&T center	Joint projects in the areas of engineering and information technology & cooperation with Indian research institutions	Bangalore	India	n/a	-	-	Active	First invest.
2010	Assembly hangar	Assembly of aft fuselage and system installations of forward fuselage sections for A350 XWB aircraft	Hamburg	Germany	€ 150	Airbus SAS	Airbus	Active	Yes
2011	Engineering center	Developing products and providing consultancy and other services to the aerospace and defense companies in India	Bangalore	India	n/a	-	Cassidian	Active	First invest.
2011	Production center	Production and assembly of metal components for all Airbus programs	Ghimbav	Romania	€ 40	Premium AEROTEC	Airbus	Active	First invest.

2011	Assembly facility	Assembly plant for A350 XWB wings	Broughton	UK	£400	Airbus SAS	Airbus	Active	First invest.
2011	Logistics center	Support to industrial exchanges between China and the rest of world	Tianjin	China	n/a	Airbus SAS	Airbus	Active	First invest.
2012	Assembly facility	Producing, assembling and maintaining the EC725s being acquired by Brazil's three armed forces	Itajubá	Brazil	€ 160	Helibras	Eurocopter	Active	Yes
2012	Final Assembly facility	A350 XWB FAL	Toulouse	France	€ 140	Airbus SAS	Airbus	Active	First invest.
2013	Production center	Production site for structures used in jetliner cargo and emergency exit doors along with tail booms to equip Eurocopter Ecureuil helicopters	Querétaro	Mexico	$100	Eurocopter	Eurocopter	Active	First invest.
2013	Engineering center	Lightweight construction and the use of new materials	Augsburg	Germany	€ 7	Premium AEROTEC	Airbus	Active	First invest.
2013	R&T center	Reinvestment on testing and research facilities including simulators, avionics trainers, laboratories, test centers and a prototype shop	Donauwörth	Germany	€ 100	Eurocopter	Airbus Helicopters	Active	First invest.
2015	Final Assembly facility	A320 FAL	Mobile AL	USA	$ 600	Airbus SAS	Airbus	Active	First invest.
2015	Production center	Helicopter blade production and to research on composite materials	Paris-Le Bourget	France	€ 130	Eurocopter	Eurocopter	Active	Replacement
2015	Design & Engineering ctr.	Design activities in rotorcraft drive systems and equipment	Łódź	Poland	n/a	Eurocopter	Eurocopter	Active	First invest.
2016	Final Assembly facility	Final assembly of the E-Fan 2.0 all-electric aircraft in Pau	Pau	France	n/a	-	-	In construction	First invest.
2017	Final Assembly facility	H215 helicopters final assembly	Brasov	Romania	n/a	Eurocopter	Eurocopter	In construction	First invest.
2017	R&T center	Development and testing centre for large structural wing parts	Filton	UK	€ 49	Airbus SAS	Airbus	In construction	Yes
2017	Completion & Deliv. ctr.	Completion and delivery of A330	Tianjin	China	n/a	Airbus SAS	Airbus	In construction	First invest.

Source: Airbus press releases and annual reports

Table 3.6b: Major Investments of Boeing between 1988 and 2014

Year of Completion	Type of investment	Core activity of the investment	Location City	Location Country	Initial cost of investment (in millions)	Subsidiary (in the year ofinvestment)	Division (during the year of the investment)	Current situation	Part of an existing facility?
1998	R&T center	Design and engineering work for new commercial aircraft models	Moscow	Russia	n/a		Commercial Airplanes	Active	First invest.
1998	MRO center	Support center for C-17 Globemaster III MRO and modification work	San Antonio TX	USA	n/a	-	Integrated Defense Systems	Active	First invest.
2000	Assembly facility	Assembly of RS-68 rocket engines	Hancock County MS	USA	$11	Rocketdyne	Network & Space Systems	Divested in 2005	Yes
2001	Machinery	Rotomold machines to manufacture Environmental Control System (ECS) ducts	Spokane WA	USA	n/a	-	Commercial Airplanes Aircraft Systems & Interiors	Divested in 2003	Yes
2002	Production center	C-17 sub-assembly facility	St. Louis MO	USA	n/a	-	M. Aircraft & Missile Sys.	Closed in 2015	Yes
2002	R&T center	Research on environmentally progressive materials and energy sources, safety and air-space management in collaboration with European R&D partners	Madrid	Spain	$10	-	Phantom Works	Active	First invest.
2002	Production center	On demand low-cost fabrication of small lots of complex, hard-to-manufacture parts with selective laser sintering technology	Camarillo CA	USA	n/a	-	Phantom Works	Divested in 2005	First invest.

2004	R&T center	Ramp and flight test as customer support services	St. Louis MO	USA	$200	-	Integrated Defense Systems	Active	Yes
2005	R&T center	Simulation environment supporting design and product integration decisions for defense programs	Philadelphia PA	USA	$4,5	-	Integrated Defense Systems	Active	Yes
2006	MRO center	MRO services of commercial aircrafts	Shanghai	China	$85	-	Commercial Airplanes	Active as a JV	JV invest.
2008	R&T center	Test and evaluation providing technology and capability to support both current and future radar-based weapon systems	Huntington Beach CA	USA	$10	-	Integrated Defense Systems	Active	First invest.
2009	R&T center	Innovation and research in collaboration with Indian R&D organizations, including government agencies, businesses and universities	Bengaluru	India	n/a	-	Research & Technology Communications	Active	First invest.
2010	FAL	FAL for P-8 Poseidon military aircraft	Seattle WA	USA	n/a	-	Defense, Space & Security	Active	Yes
2011	Production center	Production of composites components for all Boeing programs	Tianjin	China	$21	-	Commercial Airplanes	Active as a JV	Yes
2011	FAL	FAL for Boeing 787 Dreamliner	N. Charleston SC	USA	$750	-	Commercial Airplanes	Active	First invest.
2011	Assembly facility	Boeing 787 vertical fin assembly line	Salt Lake CityUT	USA	n/a	-	Commercial Airplanes	Active	First invest.
2011	Assembly facility	H-47 Chinook assembly in renovated manufacturing facility	Ridley PA	USA	$130	-	Defense, Space & Security	Active	Yes
2011	Production center	Fabrication of Boeing 787 interior parts	N. Charleston SC	USA	n/a	-	Commercial Airplanes	Active	Yes
2012	R&T center	B-1 program upgrading and C-130 Avionics modernization program	Oklahoma City OK	USA	n/a	-	Defense, Space & Security	Active	Yes
2012	Production center	Processing for machined parts for all Boeing commercial aircrafts	Gresham OR	USA	n/a	-	Commercial Airplanes	Active	Yes
2013	Production center	Fabrication of composite horizontal stabilizer components for Boeing 787-9	Salt Lake City UT	USA	n/a	-	Commercial Airplanes	Active	Yes
2013	R&T center	Research on new materials and composites manufacturing	Port Melbourne	Australia	$5	-	-	Active	Yes
2014	R&T center	Research on the development of aerospace technologies in collaboration with Brazilian researchers and scientists	São José dos Campos	Brazil	n/a	-	-	Active	First invest.
2015	R&T center	Research on aviation biofuel in collaboration with Embraer	São José dos Campos	Brazil	n/a	-	-	Active	JV invest.
2015	Assembly facility	Design and assembly of the 737 MAX engine nacelle inlet, design of nacelle fan cowl and engineering integration for the 777X nacelle	N. Charleston SC	USA	n/a	-	Commercial Airplanes	Active	First invest.
2015	Production center	Manufacturing of complex parts for the 7-series from hard metals like titanium	Helena MO	USA	$35	-	Commercial Airplanes	Active	Yes
2015	R&T center	Technologies related to simulation, avionics, materials and communications	Huntsville AL	USA	n/a	-	Research & Technology	Active	Yes
2015	R&T center	R&D on composite airplane fuselage and propulsion improvements	N. Charleston SC	USA	n/a	-	Research & Technology	Active	First invest.
2015	R&T center	Non-Destructive Test Lab, Human SI Center and Polymer Synthesis Lab	St. Louis MO	USA	n/a	-	Research & Technology	Active	Yes
2016	Production center	777X wing and empennage parts	St. Louis MO	USA	n/a	-	Commercial Airplanes	In construction	Yes
2016	Production center	Composite wing fabrication for 777X	Everett WA	USA	$1 000	-	Commercial Airplanes	In construction	First invest.
2018	Production center	Manufacturing and assembly of 747 fuselage panels	Macon GA	USA	$80	-	Commercial Airplanes	In construction	Yes

Source: Boeing press releases and annual reports

3.8 Boundaries in movement – enlarging and shrinking capabilities

As it is previously mentioned, part of the new product development strategies of Airbus and Boeing includes divestments in specific areas which are not core or low value according to their systems integration business strategy. Both firms divested a significant amount of their assets and related capabilities in 2000s. Table 3.7 provides a list of Airbus and Boeing divestments in the forms of the sales of complete business units, subsidiaries or parts of them since 1999. The comparison of divestments in detail reveals multiple dynamics with their impact on their paths of integration. In the case of Airbus which has a much larger number of divestments during the period between 1999 and 2014, sale of assets, business units or subsidiaries principally reflects its interest in consolidating its business around specific domains after the establishment of EADS as a standalone company. In the first half of 2000s, the company principally divested its IT, software and communication businesses in France and Germany while in the second half its divestments were more diversified in terms of domain and geography. General or specialized aerospace products and services, MRO services and aircraft systems and components are main segments that Airbus withdrew mainly from its home countries. Moreover, the company executed asset sales or transfers to its joint ventures especially in space and defense segments in mid 2000s. On the other hand, a solid intention to divest several major sites came in 2008 with the *Power 8* restructuring program which aimed to accumulate €5 billion of cash from 2007 to 2010 and the bulk of the monetary gains were up to internal organization restructuring through divestments, overhead reduction in the form of downsizing and other measures to increase productivity. The program was actually a guideline for the company to enable a seamless A350 development in strong compliance with its New Systems Policy. Divestments in commercial aircraft segments are mostly performed in sections that are considered low value-added by both firms. In 2007, Airbus put seven production sites up for sale particularly producing parts and aerostructure components for its commercial aircraft programs including those that are responsible to produce parts for new A350. The company managed to sell only two of them in the time of global financial crisis and it decided to reorganize remaining sites around two big aerostructures subsidiaries one in France and the other one in Germany. Divestment of a complete unit, production site or a subsidiary is the main form for both firms while Airbus has also been involved in financial transactions that change shareholding structures of units in question. The smaller number of divestments performed by Boeing in the same period tells both similar and different stories compared with Airbus. During the period the company mainly divested complete business segments such as commercial helicopters or rocket engines with the transfer of hundreds and in some cases thousands of employees. This choice shows its intention to divest manufacturing units with integrated expertise in specific fields as the company focuses on core competences and large-scale systems integration. Table 3.8 provides a list of divestments in commercial aircraft and parts manufacturing of two firms. Only *Power 8* divestments of Airbus are comparable in terms of their size to Boeing's large scale downsizing through divestitures. In all of these cases, a previous subsidiary or plant becomes a supplier to the OEM as part of the acquisition deal with the acquiring company. During the period, Boeing also divested several of McDD businesses as part of its consolidation efforts after its big acquisitions in late 1990s and early 2000s. Being a substantially US-based company in contrast with Airbus' multinational efforts, its divestments are also concentrated in the US. Another clear difference is the concentration of Boeing's divestments in the first half of 2000s, before the financial crisis, and the virtually nonexistent divestments during and after the recession. This reminds us of the potential financial motivations and valuation concerns as factors for divestment decision. In the case of Airbus, divestments are equally distributed between the periods before and after the crisis. Both companies have also been very active in the divestments in defense, electronics and services segments.

Table 3.7: Divestments of units, subsidiaries and plants by Airbus (58) and Boeing (26) between 1999 and 2015

Categories	Airbus	Boeing
By sector		
Aircraft systems, components and equipment	6	6
General aerospace products and services	4	
Helicopter manufacturing and related services		1
Communications equipment and/or services	9	
Electronic equipment and/or services		3
IT, software and related services	9	6
Space and defense products/parts manufacturing and services	8	6
Specialized aerospace products and services	11	1
MRO services	7	
Other industries	4	3
By unit/subsidiary/plant location		
France	21	
Germany	18	
Spain	2	
UK	3	1
USA	7	24
Canada		1
Brazil	1	
Portugal	1	
Russia	1	
Netherlands	1	
Belgium	1	
Finland	1	
Malaysia	1	
By purchaser's country		
France, Germany, Spain and the UK (Airbus home countries)	31	4
USA (Boeing home country)	9	20
Other European countries	6	1
Canada	5	1
Russia	1	
Israel	1	
Singapore	2	
Brazil	2	
Malaysia	1	
By the type of divestment		
complete unit/subsidiary divestment	25	21
plant/production site/IP divestment	8	4
divestment of existing majority share of an investment	7	
divestment of existing majority share of an investment to its JV	4	
divestment of existing minority share of an investment	11	1
divestment of newly issued minority shares of an investment	2	
resale of investment to its majority owner	1	
By current relation with the divested entity		
current contractor for commercial aircraft programs	**10**	**8**
current contractor for other programs	4	2

unknown/no relation	44	16
By the number of divestments per year		
1999	0	5
2000	0	1
2001	3	3
2002	0	2
2003	4	2
2004	1	3
2005	5	5
2006	7	0
2007	6	2
2008	5	0
2009	3	0
2010	2	0
2011	3	0
2012	2	0
2013	4	1
2014	5	1
2015	8	1
Total number of divestments	**58**	**26**

Source: S&P Capital IQ and company press releases

Table 3.8: Major divestments of Airbus and Boeing in commercial aircraft and parts manufacturing between 1999 and 2015

Airbus
Airbus sold its cabins factory in Laupheim to newly formed Diehl Stiftung and Thales joint venture Diehl Aircabin GmbH for €200 million in 2008 (1100)
Airbus Filton wing component manufacturing and assemblies unit was sold to GKN plc for £136 million in 2009 (1500)
Airbus sold Hamburg-based DASELL Cabin Interior GmbH, a subsidiary for aircraft cabin elements to Diehl in 2009 (650)
PFW Aerospace AG, an Airbus subsidiary, sold Specitubes tubes manufacturer for aerospace and commercial sectors to Leggett & Platt in 2013 (175)
Boeing
Boeing St Louis Fabrication Operations was sold to GKN plc in 2001 (1200)
Boeing sold its Spokane Fabrication Operation to Triumph Group Inc. in 2003 (400)
Boeing sold its wiring assembly plant in Corinth, Texas to Labinal Inc. in 2003 (800)
Boeing sold its Commercial Electronics unit based in Irving, Texas to BAE Systems North America in 2004 (800)
Boeing sold its Commercial Airplanes operations in Kansas and Oklahoma to Onex Corp (now Spirit AeroSystems) in 2005 (9000)
Boeing sold its precision-machined and sheet metal supply unit in Arnprior, Canada to Arnprior Aerospace Inc. in 2005 (370)
Boeing sold On Demand Manufacturing Inc. in Fountain, Colorado to RMB Products in 2005 (?)
Boeing closed its parts production operations at the Oak Ridge, Tennessee in 2008 (265)

Source: S&P Capital IQ and company press releases. Numbers in parentheses indicate the number of employees in units/subsidiaries at the time of divestment

In order to have a complete picture of the shifting boundaries of two companies and their systems-integration orientation, the analysis on divestments has to be complemented with the one on mergers and acquisitions. It is also necessary to understand the growth strategies of the two firms and to show the dual role of divestments and acquisitions.

Companies resort to mergers and acquisitions for several reasons including competence development in specific fields. This is also true for Airbus and Boeing as they are active acquirers of firms in aerospace and other industries all over the world. Table 3.9 provides a detailed list of Airbus and Boeing acquisitions between 1999 and 2015. Similar to divestments, Airbus has been much more active in acquiring different types of firms within different geographies in different forms. For both firms, it is rather a heterogeneous group of businesses being acquired in a variety of forms including financial investments such as acquisitions of minority stakes. Sectors such as IT, electronics of specialized aerospace products and services are highly represented. The company is equally active in acquiring MRO businesses and in divesting them. For Boeing, more than half of its acquisitions are in IT, communications and electronics fields. The intention of both companies to keep enlarging their technological capabilities in a great variety of fields shows their interest in using systems integration as part of their extended corporate strategies which are principally about leveraging existing capabilities, knowledge and experience in newly developing business segments within aerospace which are highly connected to IT, electronics and communications technologies. Whether systems integration is principally used as a narrative to focus on core competencies that two companies have been developing for decades, it is observed, on the contrary a diversification of businesses especially in aircraft systems, components and equipment that are still connected to traditional aerospace manufacturing.

As a result, in contrast with the systems integration perspective, these companies are trying to extend their knowledge base beyond their core competencies. Such a strategy also helps them to keep these units close to the outer boundaries of the firm that they can rather easily divest them as long as they are not inseparably integrated into their existing business areas. For example, one of the biggest acquisitions of Boeing as part of its strategic growth plan was the purchase of Jeppesen Sanderson in 2000 which is a provider of flight information services to airlines and other operators. The new subsidiary kept acquiring smaller other firms in the US or Europe to extend its access to different fields and geographies. The company still operates as a separate, distinct unit within Boeing. Connexion, another separate unit of in-flight online internet connectivity service was dissolved in 2006 due to lack of market for such services at that time according to the company. As early as 2002, it was counted by the company as one of the major business areas where Boeing could leverage its core competencies[26]. Thus the relations between integration, technology development and market success are crucially important for companies. Divesting and acquiring similar lines of businesses should have other reasons than 'strengthening core business' like subsidiary level profitability. Especially Airbus is an active acquirer of the MRO, communications and IT and software businesses while it is also divesting similar businesses in same domains.

Compared to other fields, acquisitions in commercial aircraft segments constitute a smaller percentage for both firms showing their willingness to diversify their activities within aerospace. Nevertheless, Airbus is more active than Boeing in acquiring specialized businesses in different segments within aerospace and commercial aircraft manufacturing.

Similar to divestments, Boeing is much more concentrated on its home country in acquiring new businesses. More than three-fourths of its acquisitions are located in the US and during the past fifteen years it did not acquire any businesses from Airbus' home countries. Airbus, on the contrary has a greater diversity of acquisitions in terms of their locations while it has a strong concentration on its home countries and Europe as a whole.

Table 3.9: Acquisitions of Airbus (87) and Boeing (48) between 1999 and 2015

Categories	**Airbus**	**Boeing**
By sector		
Aircraft systems, components and equipment	11	8
Specialized aerospace products and services	13	2
Space and defense products/parts manufacturing and services	7	1
Helicopter manufacturing and related services	3	
All aerospace products and services	3	
IT, software and services	11	23
Communications equipment and/or services	5	6
Electronic equipment and/or services	11	3
MRO services	11	1
Diversified metals and mining		1
Other industries	12	3

[26] "Speech of the Executive Vice President, Chief People and Administration Officer Laurette Koellner", *The Boeing Company*, September 18, 2002

By country of acquired entity		
France, Germany, Spain and the UK (Airbus home countries)	48	2
USA (Boeing home country)	8	35
Other European countries	14	3
Canada	1	1
Russia	1	1
Japan	3	1
China	3	1
South Korea		1
Malaysia	1	1
Saudi Arabia	1	
Brazil	2	
Argentina	1	
South Africa	2	
Australia	1	2
New Zealand	1	
By previous relation to the acquirer		
First time acquisition with majority stake	49	40
First time acquisition with minority stake	16	3
Completion to 100% of existing investment	12	
Already invested with minority holding	5	
Acquisition is performed by an existing JV	3	
Already invested as a JV	2	5
By current situation of the acquisition		
Still active as a subsidiary	58	32
Inactive/merged with other business units/subsidiaries	16	13
Divested/dissolved	9	2
Plant/production site purchase only	4	1
By the number of acquisitions per year		
1999	0	2
2000	2	9
2001	7	1
2002	5	1
2003	6	1
2004	2	1
2005	5	0
2006	11	3
2007	2	2
2008	8	11
2009	6	5
2010	7	4
2011	13	1
2012	5	2
2013	2	1
2014	3	3
2015	3	3
Total number of acquisitions	**87**	**48**

Source: S&P Capital IQ and company press releases

While there is a comparatively limited interest by the two companies in acquisitions abroad, their capability development efforts have been largely extended beyond national borders during the same period. Like any other big manufacturing company, aerospace companies including Airbus and Boeing have gained an important global foothold in the last two decades. National efforts of emerging countries to build their own aerospace industries have also played a strong role in the expansion of Airbus and Boeing. Today both companies are investing in aerospace capabilities in other countries including developing economies and especially in China. They have two major strategies for foreign expansion. First of all, they continue to form joint ventures with partner firms, a historically important form of collaboration prevalent in aerospace (Deloitte, 2013; Dussauge and Garrette 1995; Mowery, 1988)**.** When partners get through the organizational and technical challenges, joint ventures in aerospace generally promise enhanced economic performance, better co-monitoring, reduced opportunistic behavior (Mowery, 1988), and scale economies (Dussauge and Garrette 1995). Usually consolidated in company accounts as subsidiaries, these ventures are important mechanisms for the countries they are located in order to take part in aerospace supply chains. Table 3.10 shows active joint ventures of Airbus and Boeing with related information. Besides considerably old ventures formed in the 1980s and 1990s with national partners (also with Italy in the case of Airbus), starting with the second half of 1990s, Airbus and Boeing established a number of joint ventures with companies from the developing world. Similar to acquisitions, Airbus is much more active in launching such initiatives than Boeing (34 active joint ventures for Airbus compared to 16 for Boeing). Its willingness to form joint venture partnerships as long-term collaborations with these economies in non-commercial aircraft areas like defense and space markets is different than that of Boeing which mainly prefers contract specific collaborations with partners out of the US in such fields. Advanced metals, biofuels and innovative designs for future aircraft are other commercial fields in which these companies collaborate with other entities.

In commercial aircraft manufacturing, national firms of China and to a lesser extent Russia, India and Malaysia are important partners for both firms. In China, joint ventures are historically important business partnerships to adapt to new technologies and to help capability development efforts of the economy (MacPherson and Pritchard, 2003). Airbus and Boeing formed several ventures with Chinese aerospace companies especially in composite manufacturing and Airbus also has a final assembly line in Tianjin, China manufacturing A320s primarily for Chinese airlines. The company opened its fourth A320 final assembly line in Alabama, USA in 2015 after Toulouse, Hamburg and Tianjin. In addition, thanks to its strong presence in helicopter manufacturing, Airbus has its own civil and military helicopter manufacturing assembly sites established in collaboration with local partners in Mexico, Brazil, Australia and the US.

Last but not least, next to their joint ventures, Airbus and Boeing have also been active in establishing research and technology centers in countries with available aerospace capabilities. Managed with an internal network perspective, their aim is to utilize local technological expertise by developing partnerships with local universities and research centers. Reconfigured several times in the last two decades, both companies currently have a web of independently operating technology research centers specialized in specific fields depending on the manufacturing focus of other business units in the same location or the capabilities offered by these regions. Table 3.11 provides a list of national and international technology and research centers of Airbus and Boeing. One explicit similarity is the presence of R&D centers of both companies in China, Russia and India. In these three regions, even the chronological order is the same for Airbus and Boeing in establishing research and technology centers. First they landed in Moscow, Russia, then in China (in the case of Boeing in a joint venture form) and finally in Bengaluru, India. In addition to that Airbus has had a technology center in Singapore since 2006 while Boeing established a similar center in Brazil in 2012. Internationalization efforts picked up in the 2000s parallel to increasing aerospace capability development efforts of these regions.

Both companies reorganized their national and international research centers around specific themes within aerospace. Such a trend also implies an effort to move, at least partially, innovative capabilities and the workforce that generate them away from traditional centers where their final assemblies are located. This effort is more visible in the case of Boeing which already started to reduce its R&D workforce in Washington and Southern California to relocate them in newly emerging and lower-pay, non-union centers in Alabama and South Carolina. At the beginning of 2016, the company will only have 40% of its research engineers in

Washington State and California compared to 71% at the beginning of 2014[27]. According to the same plans, there won't be a significant increase in the number of engineers abroad. The company sees faster and more efficient new technology integration into production processes[28] while it accepts that the move also aims at labor-cost savings and to "reduce our footprint where we are not as productive as we should be"[29].

In the case of Airbus, reorganization of R&D reminds us of the story of gradual integration of Airbus Industrie and its evolution to EADS and Airbus Group. Similar of its consolidation efforts to reduce duplications at every layer of management including top management, the company founded 'Innovation Works' in 2006 to consolidate specific fields of research in one or few centers compared to many before. Currently under the name of Airbus Group Innovations, research and engineering are organized around capability centers with specific themes mainly located in regions without assembly activity. It is rather a coordinated R&D centralization effort at least in its home countries.

[27] "Boeing sees big savings, others see big risks in job transfers", Dominic Gates, Seattle Times, April 26, 2014
[28] "Boeing Realigns Research & Technology Unit for Growth and Productivity", Boeing New Release, December 12, 2013
[29] "Boeing sees big savings, others see big risks in job transfers", Dominic Gates, Seattle Times, April 26, 2014

Table 3.10a: Active joint ventures of Airbus with its partners

Name of the JV	Country located	Founded in	JV with	Industry	Main focus of collaboration	Main customers	Total sales (in millions)*	% owned by Airbus	Partners' Country
Panavia Aircraft GmbH	Germany	1969	BAE Systems / Finmeccanica	Aircrafts and parts	Production and service support of Tornado military aircraft	UK, German, Italian and S. Arabian governments	n/a	42.5	UK & Italy
GIE Avions de Transport Régional	France & Italy	1981	Finmeccanica group	Aircrafts and parts	Turboprop regional aircraft production		$1,630	50	Italy
Eurofighter Jagdflugzeug Gmbh	Germany	1986	BAE Systems / Finmeccanica	Military aircrafts and parts	Development and production of Eurofighter Typhoon fighter aircraft	UK, German, Italian, Spanish, Austrian and S. Arabian governments	$7,300	46	UK & Italy
Eurockot Launch Services GmbH	Germany	1995	Khrunichev State Research and Production Space Center	Aerospace and defense	Low earth orbit satellite launch services using the Rockot system	Worldwide	51	51	Russia
Vinaero Ltd.	Vietnam	1995	Openasia Group	MRO services	MRO services for helicopters and leasing		n/a	50	Vietnam
UMS Holding S.A.S	France & Germany	1996	Thales	Semiconductor Equipment	Radio frequency, ultra wave, and mm wave components and systems		n/a	50	France
Hua-Ou Aviation Training Centre Ltd.	China	1996	China Aviation Supplies Holding Company	Aerospace and defense	Customer services	Asia-Pacific and Chinese airlines	$19	50	China
Hua-Ou Aviation Support Centre Ltd.	China	1996	China Aviation Supplies Holding Company	Aerospace and defense	Customer services	Asia-Pacific and Chinese airlines	n/a	50	China
Maîtrise d'Œuvre Système S.A.S	France	1999	Thales	Professional, Scientific, and Technical Services	PM and engineering for Air Command and Control System	French army	€ 55	50	France
COHC General Aviation Maintenance & Engineering Company	China	2001	CITIC Offshore Helicopter Company (COHC) / Samwell Aviation Ltd Co	MRO services	MRO services for helicopters		n/a	21	China
MBDA Holdings SAS	France	2001	BAE Systems / Finmeccanica	Guided Missiles and Components	Missiles and missile systems for army, navy, and air force sectors	Worldwide	$3,717	37.5	UK & Italy
Inmize Sistemas S.L.	Spain	2002	Indra / MBDA / Izar	Aerospace and defense	contractor for the European METEOR missile programme	European governments	n/a	25	Spain
S.C. Eurocopter Romania	Romania	2002	IAR S.A. Brasov	MRO services	MRO services for helicopters	Local and reg. customers	$48,7	51	Romania
Matrium GmbH	Germany	2003	Logistikzentrum Allgäu GmbH & Co. KG	Air Freight and Logistics	Logistics services for defense industry, aerospace specialists and manufacturers	Airbus and major European industrial firms	€ 39	49	Germany
The Engineering Centre Airbus Russia	Russia	2003	Kaskol Group	Aircraft Systems, Components and Equipment	Design work for concepts, aerostructures, systems installation and serial activity	Airbus	n/a	50	Russia
AEROChain	Brazil	2004	Embraer	IT, software and services	IT and communication tools for supply chain, technical support and maintenance management	Embraer	n/a	50	Brazil
Atlas Elektronik GmBH	Germany	1902**	ThyssenKrupp Technologies Beteiligungen GmbH	Defense electronics	Electronics and communication equipment for defense systems	Original defense equipment manufacturers	$550	49	Germany

Airbus (Beijing) Engineering Centre	China	2005	Hafei Aviation Industry Company Limited (HAI, 18%) / Jiangxi Hongdu Aviation Industry Company Limited (7%) / China Aviation Industry Corp I (5%).	Aircrafts and parts	Design work for Airbus current and future Aircraft programmes.	Airbus	$12	70	China
AirTanker	UK	2007	Babcock/ Cobham / Rolls-Royce / Thales	Aerospace and defense	Air-to-air refuelling and air transport aircraft for the UK Royal Air Force	UK Royal Air Force	$360	40	UK & France
Tarmac Aerosave SAS	France	2007	SITA (GDF Suez Group) / SNECMA (Safran Group) / EQUIP'AERO Ind.	Aerospace and defense	Storage, maintenance, and recycling of aircrafts	Worldwide airlines	€ 10	n/a	France
Airbus (Tianjin) Final Assembly Co., Ltd	China	2007	China Aviation Industry Corporation	Aircrafts and parts	Final assembly of A320 commercial aircrafts	Chinese airlines	n/a	51	China
Harbin Hafei Airbus Composite Manufacturing Centre	China	2009	Harbin Aircraft Industry Group Co Ltd / Hafei Aviation Industry Co Ltd / AviChina Industry&Tech Co Ltd / Harbin Development Zone Infrastructure Dev. Co Ltd	Aircraft Systems, Components, Equipment	Manufacturing composite material parts and components for the Airbus A350 XWB programme and Airbus A320 Family aircraft	Airbus	n/a	25	China
Emiraje Systems L.L.C.	UAE	2009	C4 Advanced Solutions	Engineering Services	Customized communications and control systems	Middle East defense markets	n/a	49	UAE
L & T Cassidian Limited	India	2011	Larsen & Toubro Limited	Electronic Equipment and Instruments	Defense electronics		n/a	26	India
Signalis	Germany	2011	Atlas Elektronik	Surveillance systems	Maritime safety and security solutions	Port Authorities, Cost Guards, etc.	$29	79.6	Germany
Eurocopter Kazakhstan Engineering	Kazakhstan	2011	Kazakhstan Engineering	Aerospace and defense	Assembly and customization of EC145 helicopters		n/a	50	Kazakhstan
EuroCryospace Deutschland	Germany	2012	Air Liquide	Aerospace and defense	Production of the cryogenic tanks of the upper stage of Ariane 5 ME	European Space Agency	n/a	50	France
EuroCryospace GIE	France	2012	Air Liquide	Aerospace and defense	Design, development, marketing and qualification of cryogenic tanks	European Space Agency	n/a	50	France
Cassidian Airborne Solutions GmbH	Germany	2012	Rheinmetall	Electrical Equipment and Component Manuf.	Manufacturing of the unmanned reconnaissance system KZO	German Armed Forces	n/a	51	Germany
Energia Satellite Technologies Ltd.	Russia	2013	Energia	Spacecrafts, Space Structures and Components	Telecommunication and Earth observation satellites for Russia	Gazprom Space Systems, Russian Satellite Communications Co	n/a	49	Russia
Space Launcher	France	2014	Safran	Spacecrafts, Space Structures and Components	Development of Ariane 5 ME launcher and Ariane 6 launcher variants	ESA, National Space Agencies, Arianespace and satellite operators.	n/a	50	France
Airbus Helicopters Simulation Center Malaysia	Malaysia	2015	BHIC Defence Technologies Sdn Bhd	Aerospace and defense	Customer services	Military, paramilitary, and civil helicopter operators in Asia-Pacific	n/a	70	Malaysia
Airbus Asia Training Centre	Singapore	2015	Singapore Airlines	Aerospace and defense	Customer services	Aircraft pilot training services in the region	n/a	55	Singapore

*in 2013 or latest available year, **Became an Airbus joint venture in 2005

Source: Company web sites, news releases and annual reports

Table 3.10b: Active joint ventures of Boeing with its partners

Name of the JV	Country located	Founded in	JV with	Industry	Main focus of collaboration	Main customers	Total sales (in millions)*	% owned by Boeing	Partner's Country
HRL Laboratories, LLC	USA	1948**	General Motors	Electronic Components	Microelectronics, sensors and materials for automotive, aerospace, defense applications	US Navy, DARPA, Boeing and General Motors	$46.1	50	USA
Hellfire Systems LLC	USA	1974***	Lockheed Martin	Missiles and Components	Production of the AGM-114 Hellfire, an air-to-surface missile	US and other armies	n/a	50	USA
Bell-Boeing Joint Program Office	USA	1981	Textron Inc.	Military Aircraft	Development and production of Bell Boeing V-22 Osprey military tiltrotor aircraft	US Army	n/a	50	USA
Alsalam Aircraft Co.	Saudi Arabia	1988	The Cooperation Council for the Arab States of the Gulf	MRO Services	MRO for Boeing manufactured aircrafts	Royal Saudi Air Force and miscall. airlines	n/a	unknown	Saudi Arabia
Boeing Sikorsky Aircraft Support	USA	1993	United Technologies Corp.	Air Freight and Logistics	Logistic and engineering assistance to army special operations forces	US Army	$21.6	50	USA
United Space Alliance, LLC	USA	1996	Lockheed Martin	Spacecraft and Satellites	Space operations, services, and technologies	NASA and NASA suppliers	$1817	50	USA
Aerospace Composites Malaysia Sdn Bhd	Malaysia	1998	Hexcel Corporation	Aircraft Systems, Components, Equipment	Manufacturer of flat and contoured structure composite bond assemblies	Boeing suppliers	$50.3	50	USA
Aviation Training International Limited	UK	1998	AgustaWestland Finmeccanica	Education Services	Aircrew, Groundcrew and Maintenance Training	UK Ministry of Defence	$48.3	50	UK & Italy
Aviation Partners Boeing, Inc	USA	1999	Aviation Partners, Inc.	Aircraft Systems, Components, Equipment	Advanced technology blended winglets	Boeing	$10.2	50	USA
Boeing Tianjin Composites Co., Ltd.	China	1999	Aviation Industry Corporation of China	Aircraft Systems, Components, Equipment	Composite parts for secondary structures and interior applications	Boeing	n/a	80	China
Morocco Aero-Technical Interconnect Systems	Morocco	2001	Labinal Snecma Safran	Aircraft Systems, Components, Equipment	Manufacturing general-purpose wire bundles	Boeing, Labinal Snecma	$73.9	50	France
United Launch Alliance, LLC	USA	2006	Lockheed Martin	Spacecraft and Satellites	Spacecraft manufacturing and launch services	DoD, NASA, National Reconnaissance Office, U.S. Air Force	$488	50	USA
Boeing Shanghai Aviation Services Co. Ltd	China	2006	Shanghai Airport Authority & China Eastern Airlines	MRO Services	MRO for Boeing manufactured aircrafts	Miscellaneous airlines	n/a	60	China
CJSC Ural Boeing Manufacturing	Russia	2007	VSMPO-AVISMA Corporation	Diversified Metals and Mining	Titanium parts for its 787 Dreamliner jets	Boeing	n/a	69.5	Russia
SoftBank Satellite Planning Corp.	Japan	2015	SoftBank Group	Spacecraft and Satellites	Satellite based response communications systems	Japan's Ministry of Internal Affairs and Communications	n/a	unknown	Japan
Boeing - Tata Joint Venture	India	2015	Tata Advanced Systems	Aircraft Systems, Components, Equipment	Manufacturing of aerostructures	Indian Air Force	n/a	unknown	India

*in 2013 or latest available year, **Became a Boeing joint venture in 2000, ***Became a Boeing joint venture in 1996

Source: Company web sites, news releases and annual reports

Table 3.11a: Major design, research and technology centers of Airbus

Country	City	Launch year of research activity	Site type	Main focus of new or existing research activity
France	Toulouse	before 2000	Design office	Integrator architecture, general design, integration tests and systems, propulsion, structural design and computation
France	Suresnes	before 2000	R&T center	Main Airbus Group Innovations site with several technologies researched
Germany	Hamburg	before 2000	Design office	Cabin and cabin systems, structural design and testing
Germany	Bremen	before 2000	Design office	Entire process chain of high-lift systems, design and engineering of the cargo loading systems for commercial programs
Germany	Ottobrunn	2002	R&T center	Main Airbus Group Innovations site with several technologies researched
Germany	Donauwörth	2013	R&T center	Airbus Helicopters research facilities which include simulators, avionics trainers, laboratories, test centers and a prototype shop
Spain	Getafe	before 2000	R&T center	Composites and tooling design and development
UK	Filton	before 2000	Design & Engineering center	Systems integration design for manufacturability, structures and aerodynamics technologies, aircraft sub-system integration and technologies
USA	Wichita, KS	2002	Design & Engineering center	Wing design and engineering for the A380 and other Airbus long-range aircraft
Russia	Moscow	2003	Engineering center	Design on fuselage structure, stress and systems installation, cabin interiors and freight compartments. Development of 3D digital mock-ups for the design of Airbus aircraft
China	Beijing	2005	Engineering center	Specific design packages for new aircraft programmes
Singapore	Singapore	2006	R&T center	Joint projects in the areas of aeronautics, security, computing and communication, and cooperation with Singaporean research institutions
USA	Mobile, AL	2007	Engineering center	Engineering for various interior elements of commercial programs including design and engineering of the cabin, crew rest, lavatories and galleys
India	Bengaluru	2009	Engineering center	Modeling and simulation covering such components as flight management systems, computational fluid dynamics (CFD) and digital simulation and visualization
India	Bengaluru	2011	Engineering center	Defense oriented center of excellence
Poland	Łódź	2015	Design & Engineering center	Mechanical design activities in rotorcraft drive systems and equipment of future military and commercial helicopters and modernization of existing rotorcraft types

The list does not contain final assembly lines, other assembly facilities, production and MRO centers.

Source: Company web sites and press releases.

Table 3.11b: Major design, research and technology centers of Boeing

Country	City	Launch year of research activity	Site type	Main focus of new or existing research activity
USA	Huntsville, AL	before 2000	R&T and design center	Simulation, avionics, decision analytics; metals and chemical technology
USA	California State	before 2000	R&T and design center	Flight sciences, electronics and networked systems, structures
USA	St. Louis, MO	before 2000	R&T and design center	Systems technology, digital aviation and support technology, metallics and fabrication development, nonmetals synthesis lab
USA	Washington State	before 2000	R&T and design center	Manufacturing technology integration
USA	North Charleston, SC	2015	R&T and design center	Manufacturing technology and improvements
Russia	Moscow	1993	R&T and design center	Design of aerospace structures, engineering work on commercial aviation, IT and space
Spain	Madrid	2002	R&T center	Air traffic control, safety, security, energy sources and environmentally progressive materials
Australia	Melbourne	2008	R&T center	Research and engineering on aerostructures, composite materials, and robotics for manufacturing automation
India	Bengaluru	2009	R&T center	Research and engineering on aerostructures, aerodynamics and electronic networks
Brazil	São José dos Campos	2014	R&T center	Research in sustainable aviation biofuels, advanced air traffic management, advanced metals and bio-materials

Source: Company web sites and press releases. The list does not contain final assembly lines, other assembly facilities, production and MRO centers.

3.9 Conclusion of the chapter

As stated almost two decades ago by Boeing President of Boeing Commercial Airplanes that large airplanes were approaching theoretical perfection, in terms of physics, aerodynamics, and overall performance; in the new global supplier business model, process improvements and innovations would be the responsibility of suppliers (Soscher, 2011). As the principal decision makers who hold strategic control over the allocation of resources (Lazonick, 2010b), corporate top executives are the main actors who give direction to the product strategy of their companies and required reallocations during or after each new product is developed.

Accordingly, crystallized in their latest aircraft programs A350 and B787, Airbus and Boeing have been adopting new strategies of product development and production organization since the late 1990s. Having redefined their supplier organizations and introduced new mechanisms of procurement and coordination, their common aim has been to cut development costs, to focus on final integration of aircraft systems and to reduce production lead times. Today, both companies claim that they have adopted a systems integration perspective in which, together with their design and development, manufacturing of major aircraft sections and systems is mainly performed by suppliers. And the two companies claim to focus on their 'core competencies' primarily restricted to final assembly and supply chain management. Accordantly, they have been pursuing several cost-cutting programs in order to keep product development and manufacturing costs under control and to boost earnings, with important employment and financial implications.

In the case of Boeing, the systems integration perspective is much more pronounced and applied at the strategic level. In terms of the basic definition of systems integration, both firms' orientation towards extensive outsourcing and divestment of 'non-core' elements are remarkable. In the meantime, the patent analysis as well as the research on their acquisitions and investment have shown that the intention of both companies to keep enlarging their technological capabilities in a great variety of fields reflects their interest to use systems integration only as a part of their extended corporate strategies which are principally about leveraging existing capabilities; acquiring knowledge and experience in newly developing business segments within aerospace which are highly connected to IT, electronics and communications technologies; and extending collaboration with other entities in a rather cumulative way based mostly on their historical connections than a radical overhaul of their value chains.

The research has revealed that the orientation towards leaner industrial base is questionable when the companies are compared. There is equally relevant evidence of integration and disintegration depending on the highly normative understanding of the term "systems integration" by the companies. Especially in investments related to soft businesses like electronics, IT or services, the definition of systems integration is highly ambiguous as both companies invest and divest in these domains simultaneously.

Contrary to earlier assumptions of geographical shrinkage of productive activity of Boeing (MacPherson and Pritchard, 2007) after major divestments all around, we see a reshuffling and further dispersion of R&D and production sites of both firms. Increasing global footholds in terms of rising out-of-home R&D investment and joint ventures to tap local skills, resources and markets works against some systems integration perspectives arguing increasing specialization (Pavitt, 2003) or enlarging gap between 'know' and 'do' (Brusoni et al., 2001). But the analysis confirms other approaches to systems integration such as the 'visible hand of the Chandlerian organizations' to coordinate learning trajectories of suppliers (Dosi et al., 2003) or a redesign of an existing production system and business organization in order to take full advantage of product and process innovations (Best, 2003).

Broadly speaking, one of the major differences between the two firms is in geographical extension of their knowledge and production bases. Compared to Airbus' much more active strategy to enlarge and contract its boundaries through higher numbers of acquisitions and divestments as well as investments out of its home countries, Boeing's investment strategy is largely restricted to the US while its outsourcing is characterized by a greater geographical dispersion compared to Airbus.

An important structural difference which is represented in their divergent growth rates in employment, revenue and innovation investment in the last 15 years, is the broader and more integrated productive base of Airbus in commercial segments independent of any defense or space base which is still a major source of innovation and revenue for both firms. Even in its latest and most outsourced program, the company still keeps important parts and sections manufacturing next to its final assembly. Its strong presence in helicopters, turboprop aircrafts and electronics shows its strength in civilian segments of aerospace industry as a whole.

In the meantime, the growth of suppliers from all over the world through bigger and more complex workpackages assigned by Airbus and Boeing is a new phenomenon and the winners are US suppliers in terms of their massive participation in all Airbus and Boeing programs. Decentralization, at least in the case of aerospace manufacturing, is not relevant so far. Compared to many other sectors, upgrading of developing economies remained a slow and challenging process in the case of aerospace due to the distinct characteristics of the industry discussed in Chapter Two.

Discussing the decision-making process of introducing technically advanced products by McDonnell Douglas when the company was still an independent entity, and documenting the reluctance of the firm to invest in innovation, Gillett and Stekler (1995) concluded their paper with the assumption that strategic decision-making is conditioned by the historical path of the company, its vision of its core business of building large commercial transports, and its willingness to tolerate risk despite Wall Street pressures. This is equally true for Airbus and Boeing and their history is still being written by their deliberate actions and decisions over the extent of their productive organizations. The architectures of their latest programs together with their convergent and divergent practices continue to provide important insights over their future course of action. The abilities, incentives and the willingness of the corporate actors who hold strategic decision-making positions in allocating resources to innovative activities will continue to largely define the future prosperity of their companies. However, the implementation of innovative strategies requires more than decision-making. An analysis strictly based on their business strategies is insufficient to give a clear picture of the broader orientations of the two companies' productive activities in the last two decades.

Chapter Four

‘Organization’ component of Airbus and Boeing systems-integration business/productive models

4.1 Introduction

In the previous chapter, strategy was presented as the process of resource allocation within and across the boundaries of the enterprise through skills and capital investments, knowledge generation, acquisitions, divestments, relocations, restructurings and reorganizations of value chains that are constantly redefined by corporate decision-makers. In the case of innovative firms, the decisions over the reallocation of resources primarily aim at progress of their product and process development efforts and related investments in physical and human capital. However, defining boundaries and innovative capacities cannot be explained only with an analysis of corporate resource allocation and knowledge management. In order to execute these efforts, a business enterprise has to reconfigure constantly its organizational structure in terms of its resources inseparably attached to its employees and managers. More precisely, resource allocation cannot be explained independently from organizational dynamics of labor.

A primary action of strategy remaking and boundary redefinition is the effort of a business enterprise to invest in its own organizational capabilities. A firm’s competitiveness depends above all on its innovative capacity and the ability to utilize this capacity within a broader corporate environment. Any effort to extend innovative capacity and to follow different actions in doing so depends on the success of the firm’s personnel in enabling and running the mechanisms of value creation in the form of innovative ideas, processes and at the end innovative final products.

Thus, in order to comprehend the functioning of corporate strategy and the sources of organizational and technological change and its social determinants, it is indispensable to understand how firms mobilize their resources and their workforce to transform invested resources into products (Lazonick, 1990b). In designing resource allocation, an enterprise has to set up a working organization that utilizes the value-creating capabilities of resources to innovate (Lazonick, 2012). Thus a shop-floor focus is an inseparable part of the research on innovation, business models and industrial dynamics.

Thus, *organization* is the second dimension of the systems integration model presented in this study. The study understands organization as the functioning of the productive setting that develops and utilizes the value-creating capabilities of productive resources. The aim is to coordinate and to exploit these resources in order to generate goods and services to be sold in product markets. Thus, besides a broader strategy that decides on the resource allocation within and across the boundaries of a business enterprise, organizational integration is needed to create incentives for people possessing such resources with different hierarchical responsibilities and functional capabilities to develop and utilize the firm's productive capabilities (Lazonick, 2013).

4.2 Elements of analysis for organizational integration

However, the integration of capabilities into the production process is not automatic. As a kind of dynamic setting, this division of labor frames the forms of integration and transformation of capabilities and in doing so, it defines the skill base of the firm (Lazonick, 2005) to be mobilized. The integration of skills and the efforts of large numbers of people with different hierarchical responsibilities and functional capabilities into the organizational learning processes is the essence of innovation (Lazonick, 2013). In the final analysis, the skill formation and the access to different types of skills are central to the long-term success of a business organization (Lippert et al., 2014).

As important as skill formation and its utilization, the retention of these skills within a secure organizational structure backed up with unrestrictive career opportunities is also needed. Access to training is a crucial element of this integration process. Several studies have found an important degree of correlation between training and innovative capacities of firms in different parts of the world (Bauernschuster et al., 2009; Dostie, 2014; Gonzàlez et al., 2012). The integration of career schemes and current and future incentives are also strictly connected to skill development and training opportunities (Burchell et al., 2001; Osterman et al., 2001; Rubery et al., 2002).

Moreover, the engagement of the workforce in the development and utilization of productive resources requires organizational integration to provide incentives for workers to apply the skills and efforts toward the achievement of the business's goals. Thus skill development, incentives, and participation are keys elements of an organization's structure.

The organizational setting is also framed by employee-employer relations as well as the contestations between them. In a modern business enterprise, the duties of the workforce to create value and the incentives provided to do so are continuously negotiated by means of different mechanisms depending on organizational and institutional architectures. This aspect of the business model is particularly important in manufacturing industries where workforce engagement and its regulation through negotiations/contestations are predominantly realized through worker representation (unions) and labor's participation in decision-making (unions, work councils). In this context, Sako (2006) provides an important perspective on the importance of labor organizations' role in corporate strategy and structure and vice versa. Focused on organizational boundaries, she shows that such boundaries of corporations and unions emerge as a result of political contestation between management and labor. In effect, the conflicting strategies and structures of labor and management lead to a power play between the two sides which results in a negotiated boundary or a boundary which one party imposes on the other (Sako, 2006, p. 24). The formation of workforce representation also has important implications over organizational integration and skill development. The forms of representation and its strengths and weaknesses do not only have an impact on the functional and hierarchical division of labor. Depending on the level of influence they impose, such forms are also critical to the long-term orientation of the organization and its innovative success as long as they have an impact over the decisions on resource allocation. (Brinkmann and Nachtwey, 2013) That is workforce participation in defining organizational boundaries and innovative strategies is also fundamental.

The collective voice of labor through specific mechanisms but most importantly through their own representative organizations including employee unions are central to industrial capitalism to promote the interests of employees and to form a stable communication platform with the management. Moreover, national employment institutions also determine how a society develops the capabilities of its present and future labor forces as well as the level of employment and the conditions of work and remuneration besides internal dynamics that are specific to each business organization. For example, the practice of co-determination in Germany is an important mechanism of institutional integration of the welfare state with work on the shop floor (Brinkmann and Nachtwey, 2013; Lippert et al., 2014). Or with the substantial decline of union representation in the US, employees have lost their voice in workplaces to advance their interests, while government regulation has taken over many functions of unions with controversial consequences (Osterman et al., 2001). By influencing the means of organizing for labor, mechanisms of voice or lack of them have a powerful impact on work systems and related corporate strategies (Lippert et al., 2014).

Institutions, indeed, have an influence on how societies develop the capabilities of their labor forces as well as the level of employment and the conditions of work and remuneration (Lazonick, 2012). How forms of remuneration, workforce representation and its participation in decision making and other traditional arrangements are shaped within national contexts across decades have had great implications over the interpretations of different stakeholders of industrial transformations and related changes. For example, reactions against more flexible schemes and other workplace reorganizations can be reacted in much different ways by unions in different countries depending on their existing institutional anchors of labor rights. Similar issues like flexibility, changes in work organization, job security or career trajectories can be addressed in a variety of ways conditioned by such institutional 'rigidities' (Locke and Thelen, 1995).

The power dynamics also matter. The decisions over resource allocations are strongly driven by the power relations between the actors involved and the forms of corporate governance that specify the character of the reconciliations (Lippert et al., 2014). Employment relations are also structured by social norms and the values present in specific geographies. The relation between the changing social norms along the dynamics of different social groups attached to such norms in different geographies and the orientation of managers and corporate management cannot be overlooked (Jacoby, 2007). This aspect is especially relevant in the context of US economy as the epicenter of world capitalism and the rise of the maximizing shareholder value ideology together with its social and corporate outcomes in the last several decades.

Thus, within a business organization, value creation by deploying productive resources is socially constructed and institutionally shaped. The organization of work in a firm is structured through career schemes and skills development, modes of remuneration, seniority, benefits, and collective representation and participation into decision-making. These last two aspects of organization also form up the central link between the employee voice mechanisms and corporate governance in general (Boyer and Freyssenet, 2000a, Lippert et al., 2014). If functional and hierarchical divisions of labor that characterizes the skill base and its integration into production processes (Lazonick, 2005) is one part of this setting, collective employee representation and interests of labor that the organization protects and promotes (Sako, 2006) is the other part. As a whole, there is a coordination between functional and hierarchical divisions and company-level social processes including individual or collective bargaining, contract negotiations, and compromises which evolve in time depending on power relations in and out of the firm between different economic groups. However, the ways in which these processes are defined, are also institutionally characterized and they are subject to change from one geography to another and from one period to another.

4.3 Historical context of organizational transformations

Accordingly, it is crucial to understand organizational-institutional transformation of corporate resource allocation which is necessary to describe the changing nature of work organization and industrial relations and its connections to concurrent strategic and financial orientations. A systematic exploration of how corporate strategies interact with organizational and institutional transformation of employment might also help explain their implications over industrial relations.

Rising international competition in the 1970s and 1980s, especially through the organizational superiority of Japan and structural drawbacks of corporate governance in the United States (Boyer and Freyssenet, 1995; Lazonick and O'Sullivan, 2000) brought forward the necessity of new corporate governance forms together with the reformulation of existing work organization mechanisms. Inspired by Japanese production techniques including widely popularized lean manufacturing methods and backed up with rapidly developing IT tools to be integrated into production processes, work organization and implementation on the shop-floor dramatically changed (Jacoby, 2007). The transformation of organization coupled with a transformation of managerial functions. The concurrent rise of the shareholder value perspective which aimed to align shareholder and managerial interests had substantial impact over the corporate governance of the business enterprise globally (Christensen et al., 2008; Lazonick and O'Sullivan, 2000; Shin, 2012). Intertwined with financial transformations and the shift to shareholder value logic, a detachment occurred between management's objectives from work expressed in higher performance of workers and the emerging employment practices that shift the burden of risk from capital to labor (Thompson, 2003, 2011).

Including the firms which preserved some aspects of the old New Deal system like better job security, many corporations have abandoned such New Deal business models and the business actions have become subject to continual financial calculation (Osterman et al., 2001). To reap quick returns, dominant stakeholders controlling corporations exerted pressures on the labor force through flexible and insecure work schemes (Ladipo and Wilkinson, 2002 in Burchell, 2002). Treating employees as costs to be minimized became a norm or a component of new business models (Jacoby, 2007).

Last but not least, the tendency towards the abandonment of full employment and the changing institutional context of industrial relations in the developed economies in the period after 1970s led to weakening labor unions, eroding employment protections, collective bargaining system and employee rights (Brinkmann and Nachtwey, 2013; Osterman et al., 2001; Palley, 2007; Visser, 2006). Employment relationships became less certain and labor policies and related institutions have been less capable to handle increasingly difficult work environment (Osterman et al., 2001).

These transformations in technological, institutional and organizational contexts had major implications over work organization within manufacturing firms all over the world. One implication was on the integration of internal and external skill base into the production process. Whether it was sustained by the steady inflow of well-educated international labor into Western corporations in knowledge-intensive sectors like ICT and pharmaceuticals, the manufacturing industries of the West went under a selective stress test of competitiveness resulting in a massive wave of merger and acquisition in major manufacturing sectors including aerospace. Such a rationalization eliminated massive numbers of well-paid, unionized blue-collar jobs (Lazonick, 2012).

On the contrary, individual employees in many different occupations have long been in need of urgent learning opportunities in order to match their career trajectories and future employability to their possession of up-to-date skills (Osterman et al., 2001). The impact of such transformations in work organization on the implementation of skill development is another important issue to investigate the changing dynamics of work and employment in Western manufacturing. Treating employees as material costs to be minimized has had great implications over the pay of work as well as the current and future benefits assigned to workers.

During the same period, job insecurity has become a major issue for organizational integration (Burchell, 2002; Danford et al., 2004; Mankelow, 2002) with diverse features. Including the loss over the control over the flow of work, redesign of work and other changes at work place, insecurity can be more than a fear of losing a job. They also include the decline in employee commitment and morale (Burchell et al., 2002; Danford et al., 2004).

The long-term view of work organization is shaped by its relation to job security and the contractual agreements on working hours, actual and post-employment benefits and their different features (bonuses as profit-sharing, healthcare benefits, pensions). The employer-employee relationships are also characterized by the emergence and further evolution of different forms of reward systems. Sometimes these forms may also be undermined by counteracting mechanisms. For example, bonuses that enable workers to share in the economic success of the firm and are among the main demands of the workforce from the management (Monthly Labor Review, 1964) can become controversial within the shareholder-value orientation when economic performance is measured mostly with short-term financial performance. On the contrary, it is the long-term sustainability of the business which is crucial for employees who devote their years to earn a specific profession to be deployed within a sustainable organization. Thus, corporate restructuring has become a major driver of employment instability and job security (Sako, 2006).

Employment relations, collective representation and unions have also been part of the transformation. In many countries, employment relations have come under mounting pressure primarily due to the tension between insecurity spreading through new forms of corporate governance and old forms of collective representation and bargaining structures institutionally and culturally embedded in national economies. For example, the development of new organizational forms like networking, alliances, use of external agencies and multi-employer sites has made a clearly defined employer–employee relationship difficult to maintain under conditions where employees work under different arrangements such as project teams or as on-site employees from different organizations (Rubery et al., 2002). Inconsistency between the instability created by the efforts to downsize or restructure and the required workforce stability for work practices like ‘high performance work systems’ became widespread (Thompson, 2003).

Historically, such reorganizations of work are among the main issues handled by the collective representation of the workforce through unions. However, with shrinking unionization and coverage of collective bargaining hand in hand with declining manufacturing in Western economies, employees have lost their voice which they need for job security and protection of their rights in an insecure work environment characterized with volatile and high-turnover labor markets (Osterman et al., 2001). As a result, the power and influence of organized labor diminished throughout the developed economies (Milkman, 2013; Visser, 2006). As an indicator, large-scale strikes - historically the most effective expression of union power and leverage - largely disappeared (Milkman, 2013).

To summarize, the main issues necessary to be discussed in an industrial study in a certain context are a) the integration of the workforce into the value creation process through their skills formation and the utilization of their value-creating capabilities along the production process; b) the establishment of the motivation of the workforce through necessary incentive mechanisms or its destruction; and c) job security with the supportive or undermining institutional mechanisms. As a result, in order to comprehend the relation between the development of productive capabilities of Airbus and Boeing through their innovation and technological development efforts, an analysis of the dynamics of work organization is crucial.

4.4 Features of organizational strength and workforce characteristics: Airbus vs. Boeing

Compared to a large number of failed cases of commercial aircraft manufacturing on both sides of the Atlantic including technologically advanced initiatives (BAC, Comet, Concorde, Fokker, Lockheed Martin among others), superior performance of Airbus and Boeing resides in its managerial and organizational capabilities that transform their knowledge and skill base into commercial success. Hickie (2006) emphasizes the source of success as an outcome of organizational integration of different parties:

> *"Boeing's capability to enter the jet age with such rapidity and to such competitive effect, was significantly due to the way its research, design and manufacturing activities were managed, and on its focus on relationship marketing with key customers. Nor was such management simply a matter of formal structures and processes. It was also firmly rooted in tacit knowledge (e.g. when designers appreciate the needs of production engineers) and cultural understandings (e.g. what are reasonably demands to make of a supplier). Similarly, the teams involved in Airbus design and manufacture can draw on 35 years of direct collaboration, which have developed relationships of mutual trust and understanding. The strength of the relationships has critically underpinned the Airbus partners' willingness to move towards a more united decision-making structure".*

To develop and build technically advanced commercial (or military) aircraft, a long learning and training period, including on-the-job training, is indispensable for the acquisition of the specific skills and necessary knowledge. Training is strictly connected to the job performed where people with different levels of experience interact. Thus, the design, development and manufacturing environment operates largely as a community of designers, engineers and machinists who deploy their skills within an integral technical organization in which competence and expertise are acquired and shared with a steady flow of information (Sorscher, 2002). Moreover, on the shop floor, each airframe assembly requires unique processes and tooling, and workers need a fair amount of time to familiarize themselves with these new techniques (Kronemer and Henneberger, 1993). Continuous training is again fundamental to develop new skills strongly needed with new technologies and tooling. Learning curves as practical estimates of value creation, measure productivity improvements resulting from accumulated knowledge and networks of relationships (Sorscher, 2002). In the case of a new aircraft program skill development and retention become substantially important as a new innovative product necessitates workers who are familiar with new techniques and processes. They need training, motivation to collaborate for the new project and motivation to stay in the company if they are newly hired. The integrity of the program depends on the effective organization of the workforce, well-organized coordination and communication, and a thorough management of recruitment, training and internal mobility. In effect, internal and external coordination and communication problems were among the major reasons for repeated delays of Boeing's B787 and Airbus' previous program A380.

Learning and skill development are expressed in terms of career paths, seniority, incentives and collective representation. All professions in aerospace and particularly engineering require a long period of development. For an aerospace engineer, it takes up to 20 years to lead an engineering team depending on her permanent access to training at every stage of her career[30]. And employees of a company try to make decisions about their career development with a long-term perspective. Knowledge workers need to have unambiguous avenues of professional advancement as a major motivator (Imberman, 2001).

Maintaining a sufficient number of qualified employees in technical positions is one of the chief challenges of the industry. Recurring layoffs are not desired due to skill loss as well as the considerable investment on training (Kronemer and Henneberger, 1993). Voluntary quit rates are also low compared to other industries (Kleiner et al., 2002). Average length of service in aerospace industry is substantially higher than other manufacturing industries. In the US, the median years of tenure for aircraft industry workers was 9.7 years in 2000 compared to 6.4 years for 'Transportation equipment' which also includes aircraft manufacturing and only 5.0 years for manufacturing in general. Since 2000, the US Bureau of Labor Statistics provides only the number for transportation equipment and in 2014, it increased to 7.1 years with 5.9 years for overall manufacturing. The average length of service of Boeing employees in Puget Sound, which is one of the oldest production sites of Boeing, was 16 years in 2012. The same figure was 13.5 years in 2013 for entire Airbus workforce.

In effect, in Europe the EU directives require big companies to disclose information on social and employment aspects including but not limited to gender balance of employees, percentage of employees having benefited from training or the duration of training per employee, rate of injuries, absenteeism. In Airbus, average number of hours of training per year increased from 12 hours in 2004 to 27 hours in 2013. Such figures are not available for Boeing or US companies in general.

Figures 4.1a and 4.1b provide total and commercial aircraft employment figures of Airbus and Boeing. After the substantial increase in employment due to major acquisitions in late 1990s, Boeing's employment gradually decreased until the mid-2000s and stabilized in the last 10 years with minor fluctuations as a result of incessant increases in commercial aircraft orders

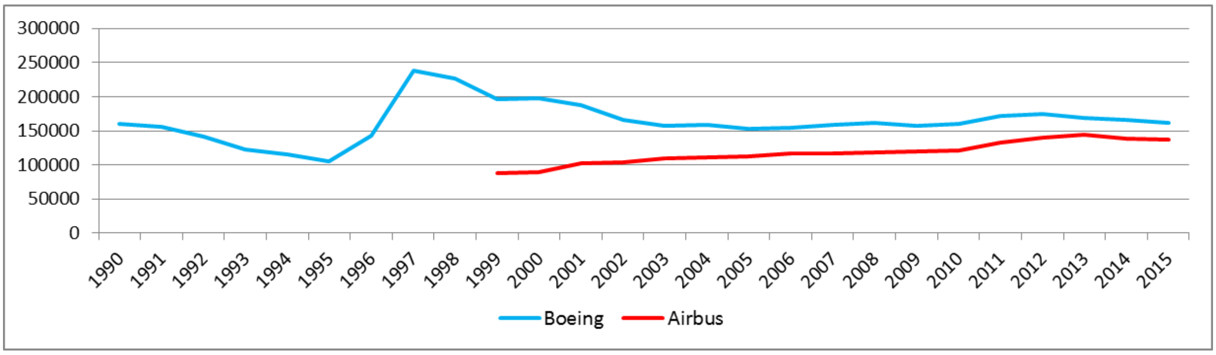
[30] "Crucial Boeing talent nearing retirement" Michelle Dunlop, Daily Herald, May 23, 2010

in this period even though defense and space share of employment has substantially decreased from its peak 51 percent in 2003 to only 30 percent at the end of 2015. The company employs today around 30,000 less defense and space workers compared to 2003 figures. Overall, Boeing's total employment in 2015 is 31% smaller compared to its peak in 1997 after the McDonnell Douglas acquisition.

The total number of Airbus employees increased more than 50% since the inception of EADS in 1999 while a stabilization of employment is also observed in the last three years despite sharply increased commercial backlog. Figure 4.1b shows the stronger increase in commercial aircraft employment in both firms in the same period. Between 1999 and 2015, the ratio of Airbus commercial aircraft employment to total employment has increased from 36 to 53 percent. For Boeing the same ratio moved from 48 to 52 percent for the same period even though it decreased to as low as 32 percent in 2005.

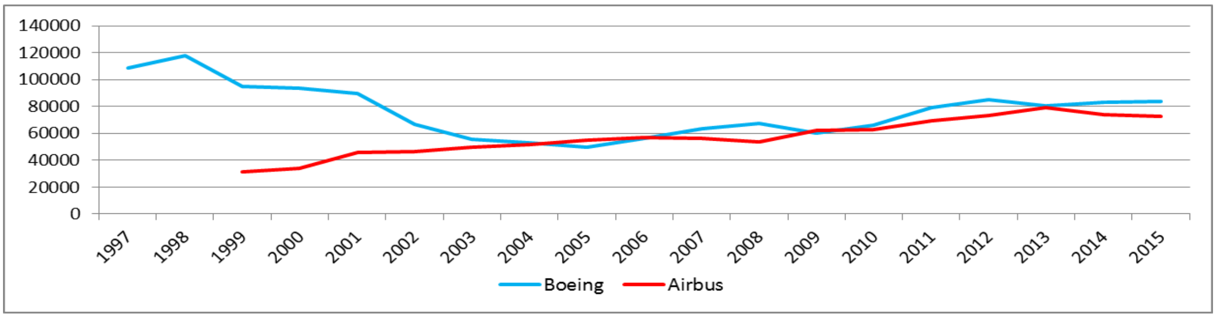
For both companies, the bulk of their workforce is located in their home countries. In the case of Airbus, the proportion of domestic workforce (employees in France, Germany, Spain and the UK) to total workforce was 90 percent in 2014. Its employment abroad, especially in China and in the US where its final assembly lines are located ascended considerably in the last five years. As late as 2009, its home country employment was 93.5 percent, close to Boeing's latest estimate which was 95 percent in 2013. The company does not officially publish the total figures of its US employment. Its 'other locations' category which includes both international and other smaller US employment figures other than the nine States where the company has its biggest part of workforce, was 17 percent at the end of 2015.

Figure 4.1a: Total workforce of Airbus and Boeing



Source: Company annual reports

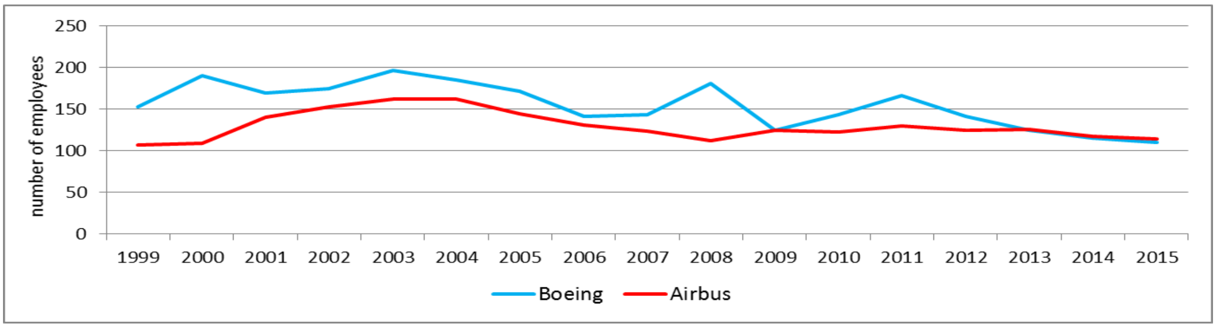
Figure 4.1b: Total commercial aircraft workforce of Airbus and Boeing



Source: Company annual reports

Relative stability in commercial aircraft employment in recent years has had a major impact on the productivity of both firms. Figure 4.2 shows the continuing decrease in the number of employees per aircraft delivered for Airbus and Boeing. Even though increased outsourcing and related divestments may explain a large part of the decrease, increased automation and higher utilization of technological advances in manufacturing also have had an important role in generating higher productivity figures, contrary to earlier assessments that aerospace is a labor-intensive industry with specific disincentives to the acquisition of labor-saving technology (Kronemer and Henneberger, 1993). As it is stated in the previous chapter, Airbus started investing in new production technologies much earlier than Boeing (Pritchard, 2002), and the introduction of new aircraft programs has always been accompanied by higher automation of manufacturing activities for the entire production process of the new program which later implemented in older programs[31].

Figure 4.2: Commercial aircraft employees per aircraft delivered at Airbus and Boeing

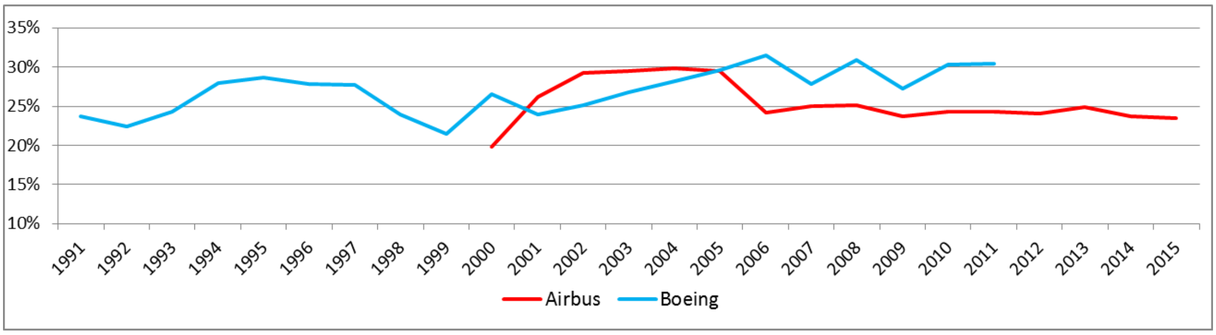


Source: Company annual reports

[31] "Rising Production Spurs Automation of Airbus Consortium Facilities", Jeffrey Lenorovitz, Aviation Week & Space Technology, Vol. 125, No. 18, November 3, 1986; "Airbus is building the wings for its new A380 jumbo aircraft with the help of a fully automated drilling and riveting machine", Adam Cort, Assembly, Vol. 49, Issue 7, July 1, 2006; "How Electroimpact is reshaping aerospace automation", Stephen Trimble, Flight International, February 29, 2016

Lastly, Figure 4.3 shows the ratio of staff costs to total costs. For both companies, the ratio fluctuates around 25% while Boeing stopped disclosing personnel expense figures since 2012 without any explanation. Considering the gradual increase in total costs in line with revenues and the decrease in employment from 174,000 to 161,400 between 2012 and 2015, the ratio should now be somewhere between 25 and 30 percent. Over the years their business strategies have shifted in favor of financial performance through cost-cutting, asset sales and increasing outsourcing (Sorscher, 2002; Trevidic, 2011[32]).

Figure 4.3: Personnel costs as a proportion of total costs at Airbus and Boeing



Source: Company annual reports

In recent years, one of the most important concerns of the industry is the aging workforce in aerospace and defense sectors (AIA, 2011; Sorscher, 2011). The average age of a Boeing worker is 48, compared with 43 of an Airbus worker. About 28 percent of Boeing's employees are 55 or older, hence eligible to retire, and their proportion is rising rapidly (Burreson, 2013). In the presence of globalization of production, ongoing technological change and the longer term possibility of new entrants in commercial aircraft markets, a key question is the extent to which Boeing and Airbus are investing in the long-term careers of their younger employees, an investment that will be required for global leadership over the next generation. In a survey conducted at the beginning of the last decade among US aerospace engineers, managers, production workers, and technical specialists, to the question whether they would recommend that their children work in this industry, less than 20 percent agreed or strongly agreed (MIT Labor Aerospace Research Agenda and Lean Aerospace Initiative, 2001).

[32] "Fabrice Brégier: «Airbus a largement dépassé ses objectifs d'économies» ", Bruno Trevidic, Les Echos, April 22, 2011

Besides career opportunities, aerospace employees seek appropriate incentive mechanisms in the form of promotion, remuneration and other benefits. Accordingly, compensation structure and policies must be clear and in accord with the professional criteria of their technical community (Imberman, 2001). The aerospace workforce is highly organized in unions all over the world. These incentive mechanisms have long been the main subjects of contract negotiations and collective representation. Industrial relations within aerospace, and especially within US aerospace, contain a history of contestations and compromises that are integral to broader managerial strategies and corporate decision-making. Employees strongly link these processes to their long term career goals and increasingly to job security. One of the most marked similarities between Airbus and Boeing is the emphasis of their workforce on job security. Similar concerns exist for every type of aerospace profession and every region the companies operate. With the rise of outsourcing as a corporate strategy (especially with more design and development outsourcing), job security has become the main topic of contract negotiations and other communication. However, the differences between the mechanisms of collective representation and employee participation on two sides of the Atlantic result in different forms of resolutions in employee-employer relationships to be detailed in the following sections.

Thus, aircraft manufacturing is a long-term proposition. Through preliminary long-term investments in education and training with major emphasis in math and science, the aerospace industry has to have constant access to a scientifically and technologically trained workforce (US Aerospace Commission, 2002). The wealth of companies primarily comes from skill retention, employment and career opportunities[33]. Manufacturers' reaction to short-term cycles through layoffs and divestments as well as postponing and cancelling new projects would hamper innovative capabilities of firms in the long run (Kronemer and Henneberger, 1993).

4.5 Work organization in Boeing

Boeing has been historically known as a paternalistic firm with structured internal promotion. Most of the company's management was composed of Boeing's professional engineers that

[33] "The success story of Airbus, Expansion 1991-1992", originally from a speech of Jean Pierson in 1991, the CEO of Airbus Industrie from 1985 to 1998, Airbus Website,

‘regard themselves more as members of a learned society than as mere employees of a corporation’ (Imberman, 2001). In the periods before and after the World War II, seniority issues were important elements of employment relationships that are marked with a strong presence of union membership to protect rights and benefits of the workforce and negotiate over them at each contract. Unionization at Boeing dates back to mid-1930s when the Wagner Act guaranteed the US workforce the right to organize in unions and to engage in collective bargaining. Right after the Second World War, engineers and other professionals also formed their unions with similar aims to machinists and other assembly workers.

The engineering mindset was also decisive over most of the top management decision-making. ‘Scientific’ decisions based on factual analysis were imposed on factory floor that all employees should logically follow orders based on the ‘truths’ formulated by senior Boeing management (Imberman, 2001). Such strict command thinking was also the result of its close relationship with the Defense Department (Newhouse, 2007).

In Boeing, contract talks with unions have always been very important to set the main topics of discussion between management and labor and negotiate various issues. These negotiations are especially critical considering the prevalent problems of communication between management and employees (Imberman, 2001), and they go beyond the traditional topics of wages and benefits and involve corporate strategies including outsourcing and productivity measures. They provide the consent of the workforce for new work and management practices to increase productivity as well as the decisions on externalization imposed by the company management.

Related to the tense relationship between management and labor, contract talks are always prone to disagreements during negotiations, which often results in strikes during the negotiations for new collective agreement[34]. The history of workforce unionizing at Boeing is also marked with a series of strikes and other major conflicts with management. Table 4.1 provides a chronology of unionization, main workplace conflicts and related issues with their reasons at Boeing. These conflicts, in effect, provide important insights to understanding the tense relation between corporate strategies and organizational integration as well as the

[34] Similar to most union contracts in the US, Boeing contracts also contains a ‘no strike’ provision which prohibit covered employees to engage in strike activities during the contract term (Lueke, 2014)

changing dynamics of company and national power relations. Workforce conflicts at Boeing have a long history with various reasons expressed mostly during the periods of new contract negotiations. As an example, when Boeing engineers went on a real strike in 2000 for the first time in the history of Boeing, the reasons were not specifically different than those of machinists'. Engineers claimed that the contract offered by Boeing would cause lower salaries and bonuses, reduced benefits with increased employee participation to costs, and redefinition of workers' responsibilities with reduced decision-making power[35]. Having a longer history of organization and strike practice, machinists' unions have had a larger variety of concerns over which to strike. As early as 1990s, outsourcing became a major concern of the blue-collar workforce, posing a direct threat to their job security[36]. Later in the next decade, more non-wage related reasons together with the aging of the workforce especially pensions and other retirement benefits have grown into one of the biggest issues of industrial relations at Boeing. It was the single most important topic in latest contract negotiations with the company in late 2013 which were turned into a major source of conflict between several parties involved. Its relation to new product development and work relocation is detailed below.

In Boeing's history of employment relations, there are other conflicts which resulted in strikes in its non-core production sites, including those located abroad. The reasons which are more or less similar to those in core sites show the extent of conflicting employment relations spread over other Boeing sites.

[35] "Thousands Strike at Boeing's Seattle-Area Plants", Jeff Cole, The Wall Street Journal, February 10, 2000; "Engineers Union Rejects New Contract from Boeing", Mike Maharry, World Reporter, February 27, 2000; "Unions Predict Gain from Boeing Strike", Steven Greenhouse, The New York Times, March 21, 2000

[36] "Machinists, Boeing Open Contract Talks", George Tibbits, The Associated Press, August 4, 1992; "Boeing union authorizes strike as talks heat up", Martin Wolk, Reuters News, September 13, 1995; "'Outsource' work still a sore spot", Jennifer Brody, Valley Daily News, December 5, 1995

Table 4.1: Chronology of unionization, workplace and contract conflicts and related issues at Boeing

year	event	major concerns
1935	US Congress passes the Wagner Act that encouraged the formation of unions	unionization
1935	Newly formed District Lodge 751 of the International Association of Machinists of the AF of L notifies Boeing that it signed up 70 percent of Boeing's plant workers	unionization
1943	Machinists in Washington protest a wage freeze enacted by the War Labor Board	war time wage freezes
1945	Boeing lays off as many as 70,000 workers as the war ends	layoffs
1946	SPEEA organizes at Boeing	unionization
1948	The Machinists union stages its first strike over wages, seniority and organizing issues. The 140-day strike remains the longest in Machinists' history	seniority
1955	Boeing agrees to a pension plan for IAM	pensions
1965	Machinists strike for 19 days over seniority issues and medical coverage	seniority
1977	A total of more than 40,000 machinists including 24,000 from Boeing (also at Lockheed) stage a 44-day work stoppage over wages, health and welfare benefits, and retirement provisions	wages and other benefits
1981	More than 900 machinists at the Kennedy space center stage an unsuccessful two-month strike sparked by the elimination of a cost-of-living allowance	other benefits (cost-of-living allowance)
1981	More than 400 Boeing of Canada workers, members of the United Auto Workers union go on strike for 30-days due to wage and cost of living discontent	wages and other benefits (cost-of-living allowance)
1987	Canadian Auto Workers members go on strike for 70 days due to imposition of a US-style management system on Canadian workers that would reduce job security and undermine the local unions' effectiveness	job security and job descriptions
1989	Machinists strike for 48 days concerned about overtime issues	overtime
1993	SPEEA members go on strike for one day for lump-sum disbursements and cost-of-living adjustments	cost-of-living wage adjustments
1995	Machinists strike for 69 days over job security and benefits	job security and healthcare benefits
1996	More than 800 machinists in Winnipeg, Canada strike for 35 days over pensions and wages	pensions
2000	SPEEA's engineers and technical workers go on strike for 40 days over wages and healthcare benefits	wages and other benefits
2002	1400 production workers at Boeing's helicopter plant near Philadelphia strike for 8 days over health-insurance benefits and work rules after contract talks failed	benefits and work rules
2005	Machinists go on strike for 28 days over retirement and health benefits in their new contract	pensions
2005	1,500 machinists at Boeing's aerospace and defense operations in three different states set a strike for three months after failing to reach terms on a contract	pensions
2005-2006	More than 30 Boeing Australia maintenance engineers in Williamtown stage a 37-week strike over the company's refusal to negotiate a collective agreement or accept arbitration	collective agreement
2006	Some 300 machinists at a Boeing Tennessee components factory strike after rejecting a labor contract over job security and benefits	job security
2008	About 660 workers at de Havilland Australia set a strike sparked by the recent dismissal of a supervisor	workplace conflicts
2008	Boeing de Havilland engineers in Australia set short-lasting strikes several times in a month to push the company into negotiating a new collective agreement	collective agreement
2008	Machinists strike for 57 days over job security, health care and retired member benefits	job security and retirement benefits
2010	Boeing defense unit workers in California set a month-long strike over pensions and healthcare benefits	pensions and healthcare benefits

Source: Dow Jones Factiva; Rodgers (1996) for years before 1980

Prior to 1980s, major topics in contract negotiations as well as the sources of conflict were remuneration of employees and seniority (Fridie, 1961). In the following period, the company progressively offered more flexible pay schemes consisting of bonuses and profit-sharing that may change according to manufacturing upturns and downturns. Management believed that such schemes would also minimize layoffs. In addition, bonuses cost less than increases in base wages, because they do not count toward sick pay, overtime, vacation pay and pension benefits[37]. Such payments were especially popular among young employees who are more interested in immediate cash than pensions or sick pay. Later in the late 1980s, however, unions wanted Boeing to abandon the bonus system as the company tied it to productivity improvements and more importantly to profitability.

On the contrary, Boeing extended its non-fixed payment schemes including share-based compensation plans to a broader group of employees in the 1990s with an aim "to link their interests and efforts to the long-term interests of the Company's shareholders" (Boeing 10-K, 1993). In 1996, the company also established a 12-year trust called ShareValue Trust that was 'designed to allow substantially all employees to share in the results of increasing shareholder value over the long term' (Boeing 10-K, 1996). The aim was to distribute every four years a certain amount of stock depending on the level of average annual stock return. Interestingly, workers' representatives expressed content that they also became eligible to receive stocks as a form of compensation like executives[38]. Concordant with the widespread trend among US firms, stock-based compensation became a prevalent form of remuneration especially for executives. Table 4.2 shows a classification of different forms of worker and executive compensation of Airbus and Boeing. Compared to less complex compensation schemes at Airbus introduced after its IPO in 2000, in the period after 1990, Boeing introduced multiple forms of compensation for employees and executives with specific conditions of eligibility. The use of the stock market as a compensation mechanism for employees is much more prevalent in the case of Boeing compared to Airbus as these options and awards in the form of company shares are distributed to a much larger group of employees. For Airbus, the number of eligible staff has never exceeded more than 1.5 percent of the total workforce. The quantitative measures of executive compensation are detailed in the following chapter.

[37] "Above All, Boeing Wants to Slow Wage Increases" Louis Uchitelle, The New York Times October 6, 1989
38 "Boeing sets up $1 billion stock fund for employees", Martin Wolk, Reuters News, July 11, 1996

Table 4.2: Previous and active compensation schemes of Airbus and Boeing for employees and executives

	Form of compensation	Year of introduction	Paid in	Given to	Conditions
AIRBUS	Wages & salaries	-	Cash	All employees	-
	Profit sharing plans (Bonuses)	-	Cash	All employees	Airbus France has profit sharing plans (accords de participation), in accordance with French law, and specific incentive plans (accords d'intéressement), which provide bonuses to employees based on the achievement of productivity, technical or administrative milestones. Airbus Deutschland GmbH's remuneration policy is, to a large extent, flexible and strongly linked to the operating profit of the company, the increase in value of the company and the achievement of individual objectives. Airbus CASA, which does not have a profit sharing policy, allows technicians and management to receive profit-related pay, subject to the achievement of the general company objectives and individual performance.
	Employee stock ownership plans (ESOPs)	2000	Stock	All employees	Until 2011, eligible employees (at least five months' seniority) were able to purchase a certain amount of shares per employee of previously unissued shares for a certain price lower than the market price. In 2011, the ESOP was changed to a matching plan concept that the company matched each fixed number of shares purchased by employees with a number of free Airbus shares based on a determining ratio. Besides ESOP, in 2013, 10 Free Shares were granted to all eligible employees of the Group to reward them for their 'engagement and commitment to the Company'.
	Annual Variable Remuneration	2000	Cash	Executives	Variable Remuneration (VR) rewards annual performance based on achievement of company performance measures and individual objectives. Performance Measures; Collective (50% of VR): divided between EBIT (45%); FCF (45%) and RoCE (10%). Individual (50% of VR): Achievement of annual individual objectives, divided between Outcomes and Behaviour. The VR is targeted at 100% of Base Salary for the CEO and, depending on the performance assessment, ranges from 0% to 200% of target. The VR is capped at 200% of Base Salary (2013)
	Long-Term Incentive Plan (LTIP) Awards (as performance units)	2000	Stock	Executives	LTIPs rewards long term commitment and company performance, and engagement on financial targets, over a five-year period. Vesting ranges from 0% to 150% of initial grant, subject to cumulative performance over a three-year period (positive EBIT). When EBIT is positive, vesting ranges from 50% to 150% of the grant based on EPS (75%) and Free Cash Flow (25%). The original allocation to the CEO is capped at 100% of Base Salary at the time of grant. The overall pay-out is capped at a maximum 250% of the original value at the date of grant. (2013)
	Stock options	2001	Stock	Executives and senior management	Stock option plans provided to the members of the Executive Committee as well as to the Group's senior management the grant of options for the purchase of Airbus shares aimed the alignment with shareholders' interest for value creation. Performance measures: Variation of the value of Airbus share compared to a grant price set at 110% of the Fair Market Value at grant date to exercise options

	Performance units	2006	Cash or Stock	Executives	Performance units are conditioned to the achievement of long-term operational profit, measured through cumulative EBIT (and EPS & FCF for CEO only). Based on 100% target performance achievement, a minimum of 50% of performance units vest; 100% in case of on-target performance achievement; and up to a maximum of 150% in case of overachievement of performance criteria. The performance and restricted shares will vest if the participant is still employed by a group company and, in the case of performance units, upon achievement of mid-term business performance.
	Restricted shares	2006	Cash	Executives and senior man.	Restricted units plan is a cash settled share-based payment plan. Restricted units vest if the participant is still employed by a Group company at the respective vesting dates
	Executive termination package	2000	Cash	Executives	The Executive Committee members are entitled to a termination package when they leave the Company as a result of a decision of the Company. The employment contracts for the Executive Committee members are concluded for an indefinite term with an indemnity of up to a maximum of 24 months of their target income.

	Form of compensation	**Year of introduction**	**Paid in**	**Given to**	**Conditions**
BOEING	Wages & salaries	-	Cash	All employees	-
	Bonuses	-	Cash	All employees	-
	Stock options	before 1990	Stock	Eligible employees	The options are granted with an exercise price equal to the fair market value of our stock on the date of grant and expire ten years after the date of grant. The stock options vest over a period of three years, with 34% vesting after the first year, 33% vesting after the second year and the remaining 33% vesting after the third year
	Stock Appreciation Rights	before 1990	Cash & Stock	Eligible employees	Stock Appreciation Rights are given to employees who are granted stock options. They are the right to receive payment per share of the SAR exercised in shares of equivalent value or in cash. Upon the exercise of a SAR, a Participant shall be entitled to receive payment from the Company in an amount determined by multiplying (a) the difference between the Fair Market Value of the Common Stock for the date of exercise over the grant price by (b) the number of shares with respect to which the SAR is exercised.
	Restricted Stock and Stock Units	before 1990	Stock	Eligible employees	The RSUs are granted to employees for various achievements and they vest on the third anniversary of the grant date. The fair values of all stock units are estimated using the average stock price on the date of grant. Stock units settle in common stock on a one-for-one basis and are not contingent upon stock price.
	LTIP Shares	1990-1995	Stock	Executives	For the years 1990 through 1995, executives received long-term incentive program performance shares (LTIP Shares). LTIP Shares are converted into shares of Boeing common stock four years after they are awarded. The officers cannot vote any of these types of share interests or transfer them unless and until they are converted into Boeing common stock, and they may be forfeited on termination of employment prior to vesting.

	Boeing Stock Units	1994-2006	Cash & Stock	Executives	BSUs, which were awarded for years prior to 2006 in payment of a portion of the annual incentive award, are stock units that earn dividend equivalents, which are accrued in the form of additional BSUs each quarter. BSUs vest and are payable three years after the award or upon earlier retirement, or may be deferred, and are payable in either cash or stock at the election of the executive. Vesting of the BSUs will be fully accelerated if employment is terminated due to death, disability or layoff.
	ShareValue Trust	1996-2010	Stock	Eligible employees	Designed to allow substantially all employees to share in the results of increasing shareholder value over the long term. The program ran for 14 years under four periods. For each fund period, the value of the trust that exceeds 3 percent annual growth is distributed to eligible participants in the form of stock (with partial shares in cash). Participants on non-U.S. payrolls will receive cash in lieu of stock. Shares of common stock held by the Trust are legally outstanding and entitled to receive dividends
	Stock equivalent units	1997 (after McDD acquisition)	Cash	Stonecipher	Stock equivalent units ("SEUs") granted to Mr. Stonecipher by McDonnell Douglas prior to the Merger were converted into 477,415 SEUs upon the consummation of the Merger. Dividend equivalents were converted into an additional 2,488 SEUs after the Merger. These units, which do not have voting rights but earn dividend equivalents that are reinvested in additional SEUs, are payable in cash.
	Career Shares	1998-2006	Stock	Executives	Career Shares (CS), which were granted prior to 2006, are stock units which are payable in shares of Boeing common stock and earn dividend equivalents, which accrue in the form of additional CS which vest upon termination of employment due to death, disability, retirement or layoff and are paid out in stock upon vesting.
	Performance Shares	1998	Stock	Executives	Stock units that are convertible to common stock contingent upon stock price performance, on a one-to-one basis. Beginning with our 2003 grants, all new Performance Shares awarded are subject to different terms and conditions from those previously reported
	Executive Layoff Benefits Plan	1998	Cash	Executives	A Layoff Event is an involuntary layoff from employment with the Company between the Effective Date and June 30, 1999, pursuant to a merger-related staffing decision An Employee's Layoff Benefit is equal to: a) One year of salary (base salary at time of layoff), plus b) Incentive target under the Incentive Compensation Plan for Officers and Employees of The Boeing Company and Subsidiaries or the McDonnell Douglas Senior Executive Performance Sharing Plan or the Performance Sharing Plan effective at the time of the Layoff Event, plus c) The Company paid portion of the cost (grossed up for taxes) for the current medical and dental coverage for the Employee and dependents for twelve months
	Performance Awards	2006	Cash & Stock	Executives	Performance Awards are cash units that payout based on the achievement of long-term financial goals at the end of a three-year period. Each unit has an initial value of $100 dollars. The amount payable at the end of the three-year performance period may be anywhere from zero to $200 dollars per unit, depending on the Company’s performance against plan for the three years ended December 31, 2008. The Compensation Committee has the discretion to pay these awards in cash, stock, or a combination of both after the three-year performance period.

Source: Company annual reports and proxy statements

As stated, the issue of pensions for Boeing workers has become a hot topic of discussion between the management and labor in time. Because of perpetual layoffs of younger employees, Boeing had and still has a rapidly aging workforce and employees became more and more concerned about their post-employment earnings, which remained pretty much the same in real terms from the late 1980s. Progressively employee-funded pensions and health care benefits have become major sources of conflict in the last two decades and have resulted in several strikes after the failure of contract talks in the 2000s. However, one of the most striking conflicts between the management and labor around pension schemes erupted in late 2013. In the early part of the year, after a long contract negotiation period, Boeing engineers and technical workers finally accepted Boeing's offer which eliminated defined-benefit pension plans for new hires, leaving them only with a defined-contribution 401(k) plan. In effect, Boeing wanted to join the already entrenched trend in the US to substitute 401(k) plans for defined-benefit plans over the last two decades. The claim was to reduce its already underfunded pension liability and increase corporate performance in terms of earnings-per-share[39]. The second and the biggest part of the dispute occurred at the end of the same year when Boeing's commercial aircraft production workers, who are also members of the International Association of Machinists, voted down a new contract proposal that would have guaranteed the 777X be built in the Seattle region but would have frozen the pension program, raised the cost of health care and created an adjusted wage scale for new hires[40]. In the first days of 2014, however, also after Boeing's initiative to search for a new place to produce the new aircraft outside Washington, the members of the union approved the contract with a 51% in favor of the agreement which freeze pension contributions in 2016 and shift to a 401(k) plan with defined employer contributions instead of their previous program of fixed benefit payments[41]. Then Boeing also eliminated defined-benefit pensions of non-union workers. The new contract was especially welcomed by younger workers who were more concerned about job security issues than older ones, those who were more concerned with the elimination of the defined-benefit pension plan. However, it also caused a disagreement between the local union and its national center in terms of accepting or rejecting the second offer. While the national center thought that the newest offer should be

[39] "Why Boeing's fighting to retire pensions", Steve Wilhelm, Puget Sound Business Journal, January 11, 2013
[40] "Why Boeing is Going to War With Its Employees", Bill Saporito, Time, November 19, 2013
[41] "Boeing Union Accepts Concessions to Keep 777X in Seattle", Julie Johnsson, Brendan Case and Peter Robison, Bloomberg Business, January 4, 2014

accepted, the local union was not that sure[42]. In the meantime, Washington State offered the largest corporate tax relief in US history, an $8.7 billion package extended to 2040 after existing tax breaks expire by 2024 in order to keep the new 777 line within the State. By pitting taxpayers, local unions, national unions, younger and older workers all against each other, Boeing management was not unintentional. At the end Boeing accomplished to a strike-free launch for its 777 upgrade, elimination of defined benefit pension plan which is still offered by only less than 10 percent of US companies and the biggest tax breaks offered by the State. With respect to employment relations, the generational difference among workers also provided a potential future issue with the dominance of a less militant labor force (Lueke, 2014). This example of putting different stakeholders one against other was not the first in the recent history of the company. As Lueke (2014) narrates;

> *"Boeing wasn't bluffing in 2009, when it demanded a 10 year no-strike deal to keep the second 787 Dreamliner production line at Everett. When rejected by the IAM, Boeing took its $1 billion U.S. investment to West Charleston, South Carolina, a "right to work" state. Boeing now manufacturers the 787 Dreamliner with non-union South Carolina workers, as well as in Puget Sound. Based upon unfair labor practice charges then filed against Boeing by the IAM, the NLRB issued a politically charged complaint alleging that Boeing had opened the South Carolina plant "in order to punish the (IAM)" for past strikes that shut down the aircraft maker's production lines in the Seattle area. The NLRB later withdrew the complaint as a result of settlement between the IAM and Boeing. At the time, the NLRB complaint was a major political issue, with U.S. Republicans charging that the Democratic Obama administration, through the NLRB, was "more interested in pleasing unions than creating new jobs.""*

From the perspective of governance compromises which mediate the impact of institutions on work (Boyer and Freyssenet, 2000a; Lippert et al., 2014), the NLRB decision on the 777 conflict is beyond the scope of a compromise between labor and management. It is rather a defeat of labor and under a different context with more balanced power relations, the results would have been very different even though the institutions and their functions remain all the same in these contexts.

Another example of this pitting one against another strategy happened in 2015. When the US Congress decided to eliminate Ex-Im Bank finance for importers of US products by providing loans to exporters at below market interest rates, the Boeing CEO declared in early 2015 that

[42] "Machinists To Vote Again on 777X Contract Jan. 3", Dominic Gates, The Seattle Times, December 21, 2013

job cuts would be unavoidable because of loss of sales due to lack of customer funding[43]. Later in the year, the new CEO announced that they already downsized some of their satellite business[44] with several hundred layoffs and a relocation of work would also be considered.[45]

Besides issues around seniority, remuneration and other benefits, the topics related to production process have also become hot topics of Boeing's industrial relations. As early as 1984, the company agreed to brief the unions annually on its plans for industrial robots, flexible manufacturing systems, computer-aided design, computer-aided manufacturing, and automation in the area of graphite composites, which have been increasingly used to replace metal in airplane structures. From the early 1990s, Boeing started to employ lean manufacturing practices and continuous work flow in order to boost productivity, to reduce inventories, to reduce delivery times (order to delivery) as an aim to free cash flow. The workforce cooperated with management as long as improved productivity brought them more secure jobs and better remuneration. However, the cyclical nature of the commercial aircraft business, continuous and rapid layoffs of employees during downturns and rising outsourcing (another issue emerged as a hot topic of discussion in the 1990s and 2000s) made it hard to estimate the long-term real impact of productivity increases and sharing of its benefits. Information exchange between the management and workforce remained very limited contrary to terms specified in contracts.

Having lack of established means to maintain the steady flow of information and two-way communication channels so that the company management can listen and respond to the needs and suggestions of the workforce (Imberman, 2001), Boeing was faced with numerous workplace conflicts especially accelerated during its systems integration period. Their impact on productive and financial performance led Boeing to introduce new methods to solve them, such as relocation of work (relocation of 787 assemble line in South Carolina) or binding employment benefits to decisions over plant location.

Together with massive layoffs intensified during the period after 1990, job security became a very important concern also for the Boeing workforce. Organized labor started to seek explicit

[43] "Boeing CEO warns of job relocations if U.S. Ex-Im Bank disappears", David Morgan, Reuters, April 23, 2015
[44] "Boeing Begins Issuing 60-Day Layoff Notices at Satellite Business, Company Says", Jon Ostrower, Dow Jones Institutional News, August 25, 2015
[45] "Boeing CEO warns of job relocations if U.S. Ex-Im Bank disappears", David Morgan, Reuters, April 23, 2015

job-protection measures without particular success. Since 1990, Boeing has laid off thousands of workers each year without rehiring incentive in general. Table 4.3 shows executed – not announced – layoffs of Boeing found through newspaper articles in comparison with Airbus. The numbers exclude reduction in workforce due to divestments of Boeing which are detailed in the previous chapter. In effect, the federal and state governments provided millions of dollars for the needs of the displaced workers and for their longer-term retraining spending in a way to help Boeing to ease its layoffs in the early 1990s (Mueller et al., 1998) as well as during other massive layoffs in 2000s through different mechanisms always funded with taxpayer's money[46].

The discussion over layoffs has to be developed in a way that it is part of corporate strategy to keep costs down while receiving government aid in different forms. Even in the boom years like the last three years when Boeing increased its commercial aircraft deliveries 25 percent and its total revenue 18 percent, layoffs at Boeing continued at full speed with different reasons. Layoffs are indicators of the level of job security offered to workers and engineers in Airbus and Boeing. For a basic comparison, as a frequently applied method extended before the 1980s, Boeing has laid off thousands of workers in face with decreasing orders either for its commercial or defense/space products. When Airbus' orders decreased for similar reasons, forced layoffs have never been applied as Airbus strategy to deal with excess labor in painful situations has always been strikingly different than Boeing. These strategies are discussed in the following section.

Laying off experienced workers in the past has caused Boeing important problems of meeting delivery schedules (Freeman, 1998). It has a similar effect with outsourcing that with less opportunities for workers, Boeing becomes less capable to perform specific work as its workers have limited opportunities to learn new skills (Peterson, 2011). Moreover, in many cases, as a kind of chain reaction, suppliers have to resort to layoffs when OEMs impose job reductions either because of productivity increases through automation or business downturns.

[46] « Good Union Benefits, Government Aid Help to Ease Pain of Boeing Layoffs", Kyung M. Song, Seattle Times, October 10, 2001; "Feds give laid-off Boeing workers a big helping hand", Dominic Gates, Seattle Times, July 31, 2013

Table 4.3: Executed layoffs of Airbus and Boeing

	Year	Year-end workforce	Reasons cited for layoffs	# of workers laid off	Notes on changes in workforce figures
BOEING	**1981**	101000	Decreasing commercial aircraft orders	6600	
	1982	95700	Lack of work for the commercial aircraft division/unit, cancellation/ reduction/end of government contract	1512	
	1983	81600	Decreasing commercial aircraft orders	9000	
	1984	93000			
	1985	104000			year of major acquisition
	1986	125000			
	1987	143700	Reduced commercial demand for the company's information processing system	60	year of major acquisition
	1988	154200			
	1989	164500	Decreasing demand for defense products, aim to reduce production costs	2200	
	1990	160500	Lack of work for the commercial aircraft division/unit	2500	
	1991	155700	Decreasing commercial aircraft orders, lack of work for the defense division/unit, cancellation/ reduction/end of government contract, downsizing at subsidiary (De Havilland Aircraft of Canada) due to decreasing orders	2759	
	1992	142000	Decreasing commercial aircraft orders, lack of work for the defense division/unit, cancellation/reduction/end of government contract, downsizing at subsidiary (De Havilland Aircraft of Canada) due to decreasing orders	4087	year of major divestment
	1993	123000	Decreasing commercial aircraft orders, decreasing demand for defense products	11073	
	1994	115000	Decreasing commercial aircraft orders, decreasing demand for defense products	6835	
	1995	105000	Aim to reduce production costs	5700	
	1996	143000	Work relocation	212	year of major acquisition
	1997	238000	End of work for the space unit	83	year of major acquisition
	1998	231000	Restructuring after McDD merger	1100	year of major divestment
	1999	197000	Restructuring after McDD merger, lack of work for the defense division/unit, decreasing demand for defense products	28598	year of major divestment
	2000	198000	Aim to reduce production costs, decreasing commercial aircraft orders	908	year of major acquisition
	2001	188000	Decreasing commercial orders after Sep 11th attacks	5000	year of major divestment
	2002	165000	Decreasing commercial orders after Sep 11th attacks	12049	
	2003	157000	Decreasing commercial orders after Sep 11th attacks	5435	year of major divestment
	2004	159000	Aim to reduce production costs, cancellation/ reduction/end of government contract	360	
	2005	153000	Decreasing Boeing 717 commercial aircraft orders, pre-divestment layoffs	700	year of major divestment
	2006	154000	Aim to reduce production costs, cancellation/reduction/end of government contract	395	year of major acquisition
	2007	159300	Work relocation	260	
	2008	162200	Aim to reduce production costs, service outsourcing	236	

	2009	157100	Work relocation, aim to reduce production costs, cancellation/reduction/end of government contract	3001	
	2010	160500	Cancellation/reduction/end of government contract, aim to reduce production costs, end of work for the space unit	1851	year of major acquisition
	2011	171700	Cancellation/reduction/end of government contract, work relocation, end of work for the space unit	211	
	2012	174400	Decreasing demand for defense products, end of work for the space unit	39	
	2013	168400	Aim to reduce production costs	2460	
	2014	165500	Cancellation/reduction/end of government contract	1160	
	2015	161400	Work relocation + lack of orders due to Ex-Im Bank shutdown	153 + >100	

	Year	**Year-end workforce**	**Reasons cited for layoffs**	**Number of workers laid off**	**Notes on changes in workforce figures**
AIRBUS	**before 1999**	n/a	During the 1990s, founding corporations of EADS (Predecessor of Airbus Group) downsized a substantial amount of their workforce due to massive cutbacks of defense spending together with consolidation and restructuring of the aerospace and defense industries all over Europe. The continent lost one third of its aerospace (civil and military) workforce between 1990 and 1996 (ASD statistics).		
	1999	88631			
	2000	88879			
	2001	102967			
	2002	103967			
	2003	109135	Between 2003 and 2008 more than 3000 jobs at the Space division cancelled as part of a restructuring program to cut costs without any forced layoffs	n/a	
	2004	110662			
	2005	113210			
	2006	116805	Non-renewal of 1000 temporary contracts at Airbus Germany	1000	Consolidation of Airbus UK
	2007	116493	In 2007 Airbus announced to cut 10000 jobs by 2010 as part of its restructuring program Power 8. Job cuts did not include termination of employment but they were composed of non-renewal of temporary workers' contracts, elimination of subcontracting work, voluntary leaves and 2 major divestments done as part of restructuring. At the end of the program in 2010, Airbus employed more people than in 2007.	n/a	
	2008	118349			year of major divestment
	2009	119506			year of major divestment
	2010	121691			
	2011	133115			year of major acquisition
	2012	140405			

	2013	144061*	In late 2013 Airbus announced to cut 5800 jobs in Defense and Space divisions by 2017 which may include 1000-1450 layoffs. Later in 2014, the company pledged not to implement any layoffs before the end of 2016	n/a	
	2014	138133			
	2015	136574			

*readjusted in 2014 to apply new IFRS rules

Source: Dow Jones Factiva

4.6 Work organization in Airbus

Compared to Boeing, Airbus' workforce represents a nonhomogeneous and less unified structure mainly due to differences in the historical development of industrial relations in countries where Airbus operates. In each country, the labor force is represented by several distinct unions and issues of collective bargaining may vary considerably depending on national differences. For Airbus, it has always been a major challenge to harmonize internal employment policies and related procedures due to differing frameworks between countries.

As late as the 1980s, the largest part of Airbus workforce was officially hired and paid by partnering companies which formed up Airbus. The company had to develop organizational identity from scratch. It had to provide a job guarantee with full appreciation of their time and work. To prevent conflicts between Airbus and its partners, precise and equitable rules had to be drawn (Koenig and Thietart, 1988) despite a diverse set of norms, rules and traditions spread over four countries of the continent.

National diversification is not the sole difficulty for employment relations. Selection of executives including the CEO has always been a hot topic. Many times during elections, national governments as major shareholders were also involved with their prerequisites regarding choices over nationalities of candidates. Many issues related to employment relations have been politically characterized.

One important mechanism to maintain management – workforce communications is the European Work Council (EWC) that was established in 2000, one year after the incorporation of EADS. EWCs are bodies representing the employees of a company at European level. They are responsible towards workers in informing them about any significant decision at the European level that could affect their employment or working conditions. They complement national work councils functioning in line with national employment regulations. Workers directly select their representatives in councils.

Signed with Airbus Industrie as early as 1992 under French law, two years before the EU Council directive which established EWCs at the EU level, Airbus EWC has largely been composed of union representatives even though these councils are institutionally separate from unions. The Council has primarily been in charge of maintaining communication and consultation about the restructuring programs of the company such as Power 8 or the latest defense and space restructuring in late 2013. Besides the Council, union representatives and the company management agreed to form a European Negotiating Group in 2010 to conduct negotiations of any transnational matter.

The Council was established to maintain a permanent dialogue and cross-border exchange of views between the Airbus workforce and its central management over the prospects of the company and general business conditions, and over specific topics including the group's structure, the economic and financial situation of the group, substantial organizational changes, new working methods or production processes, industrial restructuring, investments, relocations and employment situations and trends[47]. However, the success of the Council in maintaining a dialogue in a proactive and coordinated manner is questionable. Despite early efforts of the Council to convey the message on the details of the Power 8 restructuring program, between 2007 and 2008 Airbus workers set various strikes and work stoppages in France and Germany to protest the program and the plans for job cuts and plant closures. Table 4.4 shows this conflict and other conflicts happened between Airbus workforce and management since the early 1990s. Concerns over job security are also growing. For example, IG Metall, the strongest labor union of Airbus from Germany, tries to include clauses over job security and flexible practices each time during negotiations over collective agreement. Job insecurity is one of the biggest shared issues for Airbus and Boeing employees in comparison to differences in other areas of industrial relations.

[47] “EADS establishes European Works Council - Chairman and Co-Chairman elected”, EADS Press Release, November 8, 2000

Table 4.4: Chronology of workplace and contract conflicts and related issues at Airbus

year	event	major concerns
1989-1990	UK Engineering unions strike for 18 weeks for a shortened work week in major industrial sites including Airbus plants of BAe	working week hours
1990	Workers of Aerospatiale stage a protest on the eve of a key Airbus Industrie board meeting expected to approve a transfer of production facilities for A321 to Hamburg from Toulouse	relocation of work within Airbus partners
1992	About 163,000 metal workers including those of Deutsche Airbus stage walkouts in Germany to demonstrate solidarity with striking public service workers	solidarity walkouts
1995	More than 1000 workers at the Airbus plant of Daimler-Benz Aerospace in Bremen walk off for several hours in solidarity with the IG Metall union metalworkers strike for pay rise	solidarity walkouts
1995	Employees of Deutsche Airbus plants hold a one-day strike to protest against job cuts planned by Daimler-Benz AG	job cuts
1999	Unions at Airbus Industrie call for a one-hour work stoppage in Toulouse to protest the management's policy on pay	wages
2002	2,000 Airbus UK of the Deeside factory workers stage an unofficial walk out over pay and overtime freeze to save jobs	wages
2002	Airbus Germany workers join to nationwide warning strike of several hours to pressure employers to heed their salary demands	wages
2002	Unions at Airbus France organize a strike of several hours to press their claim for a bigger wage increase	wages
2004	German union IG Metall stage stoppages across Germany between one and two hours in a pay dispute, targeting some 200 firms including various Airbus plants	wages
2006	About 65,000 workers take part in warning strikes at 290 firms including Airbus Germany after wage negotiations with industry leaders in five German states broke down	wages
2007	*25,000 Airbus Germany workers mobilize to protest job cut announcements to implement Power8 restructuring program (February 2) *Airbus plants in German towns of Varel and Nordenham stop work for the second day while 1,200 workers in the southern town of Laupheim rally against the planned sell-off of their factory (March 1) *Thousands of Airbus France, Germany and Spain workers stop work and staged rallies to protest against job cuts (March 16) *Thousands of Airbus UK workers stage an unofficial strike amid concerns over job cuts and disappointment surrounding poor results in a company profit-share scheme (March 23) *Thousands of Airbus France workers organize a strike in Toulouse to protest Power8's job cuts plan (April 3) *Airbus Germany workers at three Varel, Nordenham and Laupheim plants walk off the job to protest against planned restructuring measures (June 6) ------- *Several hundred Airbus France workers down tools at factories in Toulouse over the lack of profit-sharing bonus (April 25) *85% of blue-collar workers of Airbus France Saint-Nazaire and Nantes plants hold a series of strikes for 2 weeks to protest inadequate profit-sharing bonuses (April 27 - May 11)	job cuts, plant closures, divestments (Power8), bonuses
2008	*Several thousand Airbus France workers stage two four-hour strikes to protest at plans to sell two sites under Power 8 (April 24 and 29) *Several hundred employees of Airbus France stage a strike to protest at management's plans to transfer the activities of its Meaulte and Saint-Nazaire sites in France to a separate subsidiary (September 30) *Airbus Germany workers at Varel, Nordenham and Augsburg facilities stage wildcat strikes over plans to spin off the factories into a new subsidiary (November 20)	job cuts, plant closures, divestments (Power8)

2009	Around one hundred Airbus France, Saint-Nazaire workers stop work for less than two hours to warn the company for low bonus offered for 2009 (April 4)	bonuses
2010	Unions at three Airbus plants organize rotating strikes for a total of 5 days on assembly lines to press demands for higher pay and oppose moves to shift some production to Germany (April)	wages
2011	Airbus Germany workers set a one-day strike after negotiations broke down after a year and a half of efforts to reach a deal on a range of issues from an employment guarantee to a ceiling on the number of temporary workers that can be hired (October 7)	job security
2014	Each time more than 1000 Astrium France workers stage four four-hour walkouts to protest management plans to lay off hundreds of employees due to Airbus Defense and Space restructuring (January 31, February 6, March 27, April 25)	job cuts
2015	Workers of Airbus ex-subsidiary Cimpa from different cities of France stage a one day strike against company's plan to sell its subsidiary (January 29)	divestments
2015	Country level walkouts organized by IG Metall in Germany to raise metallurgy workers' salaries as a pressure on continuing country level negotiations (January 29)	solidarity walkouts wages

Source: Dow Jones Factiva

In the Airbus collective agreement talks with employees are more formal and less prone to escalated conflicts and still represent national differences as contract negotiations are performed at the country level with national unions. A vibrant topic of collective agreements in each country is working time arrangements. Since its establishment as a standalone corporation in 1999, Airbus has utilized flexible employment practices regardless of the country of operation. Besides the changing working hours of full-time workers depending on rising and decreasing workloads, the company also promoted part-time and temporary work schemes and extensive utilization of contract work at company sites as part of its productivity measures.

The relative success of flexible employment practices in crisis management in Europe and especially in Germany attracts many firms to resort to more precarious employment with important organization and representation hurdles for employees (Brinkmann and Nachtwey, 2013).

For Airbus, there are several forms of action to gain flexibility. Beside continuously increasing automation to reduce the impact of any labor imbalances, Airbus also changed the composition of its workforce through temporary contracts, on-site subcontracting, flexible working hours and increasing number of part-time workers. It has not yet resorted to any forced layoffs in its history as a standalone company since 1999, but it managed to deal with downturns through the elimination of all those nonconventional contracts and reducing the working hours of its staff when necessary. This provided the company with greater flexibility and continuous revenue growth (8.1 percent CAGR between 2000 and 2014) which is far higher than its employment growth for the same period (3 percent CAGR).

While the measures like flexible working hours have been negotiated between parties without major disputes, hiring more and more employees on temporary contracts and increasing on-site subcontracting distress organized labor as it is seen as a direct threat to their existence[48]. Without any common measure of hiring, the company has continuously increased the size of its temporary and part-time workforce, especially for tasks requiring less complex skills both in Germany and France as a buffering mechanism to adjust employment levels during downturns and restructurings and to avoid redundancies. The degree of flexibility that the company reached in 2009 would have allowed it to reduce output by 20 percent without firing any full-time workers[49]. In a similar vein, during the downturn in the 1990s and early 2000s, the company offered voluntary early retirement, part-time work with some compensation for non-worked hours, or for some employee groups a shift from full-time to part-time employment for a certain period of time (Igalens and Vicens, 2006) while Boeing laid of more than 50,000 of its employees during the same period as a result of after-merger restructuring and decreasing orders following 9/11 attacks in 2001.

In Germany, where Airbus workers are represented by a single labor union but the level of temporary workers is enormously high compared to France, the company agreed to limit the ratio of temporary workers to the total workforce, stating they must not make up more than 20 percent of the workforce on each German Airbus site between 2012 and 2015, and going down to 15 percent between 2015 and 2020 in exchange for commitments to predefined productivity increases which eventually means less labor required in the coming period for the same or even an increased amount of output[50]. As a result, Airbus has been a direct beneficiary of rising flexible but increasingly precarious work schemes and the widening gap

[48] "Airbus: la CGT dénonce la montée de l'intérim et de la sous-traitance", Emmanuel Guimard, Les Echos, July 12, 2005; "Airbus Nantes: les syndicats veulent plus d'embauches", Élisabeth Bureau, Ouest France, May 30, 2012
[49] "Leading the News: Airbus eases on the brakes to avoid a stall: Despite falling orders, jet maker tries to save suppliers, skilled staff", Daniel Michaels, The Wall Street Journal Europe, April 6, 2009
[50] "Airbus Workers, Union Reach Deal, Jobs of 16,500 workers are guaranteed", Agence France-Presse, October 20, 2011

among different groups of workers in terms of job security in Europe and specifically in Germany.

4.7 Conclusion of the chapter

This chapter focused on the most controversial component of the systems integration business/productive model in terms of the complexity of institutional and organizational dynamics of work systems and their implications over the corporate governance mechanisms of two companies. It is the component where conflicting relations between stakeholders are the most highlighted and institutional interventions are the most visible. The enormous difficulty of measuring the degree of change in balance of power relations between the labor and the management within a comparison of two institutionally and historically different cases makes the component of the model highly complex and multi-faceted. Adding to this issue, the spread of the production activities and their management in Airbus across four different countries within Europe makes the comparative analysis even more difficult due to national differences in work-related norms, regulations and general practices.

Nevertheless, the analysis above has shown that the organizational aspects of two companies are the most divergent in terms of their application and impact. It is a reminder highlighted in Chapter One that the context of the identification of a model are inherent in the transformations of competitive, macroeconomic and societal contexts either at national or global levels (Boyer and Freyssenet, 2000a). Degrading practices of work in the systems integration period are not equally highlighted in two companies and certain aspects of the model like leveraging over stakeholders to extract gains through managing required flexibility and conflict resolution have considerably different forms.

Acknowledging these observations, after a brief discussion of the elements of analysis for organizational integration such as skill development, incentives, remuneration and any potential participation to decision-making and employee representation, the transformations of these elements in their historical context have been depicted. The dominance of the cost logic of the new era of industrial relations (treating employees as costs to be minimized) has been highlighted as an important component of new business models and the actions of Airbus and Boeing have been compared and contrasted. Contrary to fairly easy layoffs for Boeing as a quick solution to enable flexibility of work, different tools and mechanisms used by Airbus have been detailed. As an integral element of such practices, the channels of communication between management and labor have been emphasized and the role of institutional frameworks facilitating or undermining these channels have been underlined.

In the end, the main observation is a continuous redefinition of industrial relations highly structured by the power dynamics within the two companies. Management of both companies continuously try to modify work schemes and practices in line with work schedules, cost and market performance of their products. The adaptation of labor to these changes and their power to influence these modifications either during contract negotiations or any other time is structured to a large extent by national institutional contexts and power dynamics.

One fully shared concern of the Airbus and Boeing workforces is job security. Its impact over the organizational integration will continue to be the main issue of the future course of commercial aircraft manufacturing on both sides of the Atlantic. In both cases, the ability of labor to have an influence over the decisions on the organization of production is conditioned by the degree of power of workers' representation and participation despite institutional differences and their varying impact that may strengthen or undermine labor power in the long run.

Chapter Five

'Finance' component of Airbus and Boeing systems integration business/productive models

5.1 Introduction

The third element of the business/productive model framework is the extent of financial commitment that sustains the flow of funds required for new product development in the systems integration model. Next to this commitment, corporate decision makers also carry out certain activities to rearrange the distribution of value created through productive activity, expressed in financial terms. A coherent comparison of two companies can only be completed if these two points are identified. The similarities and differences in the degree of financial commitment required for innovation and capability development through the integration of strategy and organization, and the pursuit of financial objectives that may support or undermine this integration can only be conceived through such a comparative investigation.

5.2 Finance of innovation

To sustain the development of necessary technologies for superior products and the subsequent production process in manufacturing require high-cost investments of each type. Any business undertaking necessitates finance to keep itself afloat during the investment period until the time at which financial returns are generated through the sale of products (Lazonick, 2012). Decision makers of a company who control over the allocation of corporate resources have to guarantee the steady inflow of financial resources. These resources may either be generated through internal cash accumulated through the returns of previous investments, or bond and stock issues with favorable terms which also reflect previous achievements considering productivity and innovation. In addition, companies can also share some part of their product development and subsequent costs with their existing or potential partners; they may receive progress payments from their customers; or they may resort to governments for any form of subsidy to fund their productive efforts.

Financial commitment of corporate decision-makers and other stakeholders including governments is rather a condition than a proposition. It is the set of relations that ensures the allocation of funds to sustain innovation (Lazonick, 2013) and its level of significance is directly proportional to the magnitude of the investments in innovation bearing high uncertainty. The degree of commitment to different sources of finance may eventually condition the depth and the length of innovative efforts.

Specifically, relevant to large scale corporation cases of this study, once a business becomes a going concern after it starts generating a steady stream of revenues, the most important sources of finance are retained earnings and retentions through depreciation allowances (O'Sullivan, 2000). These earnings are yielded by organizational capabilities businesses possess, and they finance their further growth (Chandler, 1990).

While retained earnings are the major source of innovation finance for established companies, equity finance in the form of venture capital, private equity and the issuance of public equity can still be very important for young innovative firms. There is a strong link between such forms of finance and innovation which has been massively elaborated in the last decades by scholars from the US and other advanced economies.

Together with the rise of R&D expenditures all over the world especially in most productive sectors of economies including manufacturing, finance of innovation has become a standalone topic of discussion, analyzed separately from ordinary investment like capital expenditures even though they are strongly interconnected especially for industries like aircraft manufacturing where both types of spending quantitatively and qualitatively follow each other closely.

One distinct feature of innovation spending is the degree of uncertainty associated with the output. Standard finance theories may not work as long as the probability of future success of an R&D project cannot be fully estimated (Hall, 2009). Not only business analysts but also corporate decision makers may be misled by using methods of discounted cash flow (DCF) and net present value (NPV) to evaluate investment opportunities, underestimating the returns of investments in innovation. The present success of a company does not mean that it will persist in the future if the company, misinformed by these methods, does not invest in innovation (Christensen et al., 2008).

The last but not the least, government support in numerous forms including R&D tax credits can be an invaluable source of innovation finance not only for small firms but also for established ones as it was discussed in Chapter Two in the case of commercial aircraft manufacturing. And in many cases, the support does not appear at all in publicly available company statements or in government documents either for confidentiality reasons or the form of support is largely qualitative and not always measured like the use of government research labs, training of soon-to-be-hired future employees, current or even laid off staff by government programs, and the purchase of innovative goods and services by the government on favorable terms.

However, commitment does not solely refer to the control over financial input to be spent for the sake of innovation. If providing and sustaining necessary funds for R&D and other investments is one side of the coin; the other side is the control over the benefits from innovation in the form of sales revenues and their distribution among stakeholders who participate in these efforts by bearing risk with their commitment. How firms retain and distribute their revenues is strictly related to the interests of groups who control the business strategies and organizational structures of firms. The question over the control of financial resources is one of the core issues of the transformations of corporate finance in the last decades.

5.3 Recent historical context of the role of finance

For the sake of simplicity, the discussion of the evolution of finance and its role in the accumulation of the productive activities of business firms is presented here as the discussion of the topics deeply elaborated by the financialization literature.

Studied with a growing interest in the last two decades by scholars from a variety of disciplines, financialization became a convenient word to describe the rising importance of any financial tool, measure, motive or actor within the functioning of any economic activity. The impact of financialization can be extended to any act aiming to reap the returns of any investment through these tools and measures which also includes ideological and discourse-based instruments. Depending on the extent of power that is to be exerted by a specific economic actor, the benefits and the perils of financialization is unequally distributed.

The rich literature on financialization investigated a variety of actors of economic activity including but not limited to institutions, households, nations and corporations as creators and users of financial resources. An overall discussion on the findings of these studies is beyond the scope of this study, however it is necessary to highlight the major elements of this discussion with a focus on the relation between financialization and corporate behavior, in other words financialization at the corporate level with its roots in business activity and the consequences for different actors involved. In any case, the financial systems of advanced economies exerted an important influence on the development of corporate structure in facilitating organizational transformations (Mowery, 1992).

The roots of financialization can only be found within real economic or productive sectors where the value is created. The greatest success of twentieth century capitalism that gave it a renewed impetus for massive value creation was the managerial revolution which started in the US, the twentieth century leader of the world economy (Chandler, 1990). This successful model of capitalistic production stumbled with internal problems and the innovative competition coming through foreign economies especially in major consumer and capital goods sectors. Another impetus to reorganize the faltering value creation of the US economy was needed. A finance-led growth perspective was built in response to these productivity and profitability questions (Boyer, 2000).

5.3.1 The myth, the discourse and the roots of financial motives

The shift in managerial priorities along the transformation of global capitalism over the last four decades had direct implications for the utilization of retained earnings as the primary source of innovation funding for large corporations all over the world. Presented as an 'agency problem' by mainstream financial economists including Jensen (1986), as the main cause behind organizational problems of corporations or corporate governance, the conflict between shareholders (principals) and managers (agents) over the utilization of corporate resources. The ability of opportunistic agents controlling corporate resources to follow their own interests at the expense of principals could not contested by any market force (Jensen and Meckling 1976). As they have no contractual guarantee of rewards on investment, shareholders are assumed to be the only the residual claimants of the value created by corporations and the aim of a corporation should be to maximize the return of shareholders (Batt and Appelbaum, 2013; Lazonick, 2013; O'Sullivan, 2009).

Offered as a solution by economists known as agency theorists to the corporate management problems of the day, shareholder value creation gradually turned into a discursive construct independent of a firm's productive performance (Froud et al., 2006). Turning into a principle of corporate governance first among Anglo Saxon corporations, it was also entered into discussion in Europe. In 1999, the OECD issued 'The OECD Principles of Corporate Governance' emphasizing that corporations should be run, first and foremost, in the interests of shareholders (OECD 1999, in Lazonick and O'Sullivan, 2000) and its similar tone has continued in the 2014-2015 review of the principles (Lazonick, 2015b).

5.3.2 Shifting roles of actors

Also connected to the proposed agency solution, another reaction to the problem of declining returns from productive investment was the shift of capital from production to financial assets in search of superior returns (Krippner, 2005). In effect, this shift was only possible through the acts of a specific group of shareholders; the institutional investor who was potentially capable of imposing collective power (Dobbin and Zorn, 2005; Morin, 2006; Williams, 2000). The imposition was through influencing the value of their own investments; corporate stocks and to facilitate necessary regulatory changes to render their activities eased and expanded together with other actors of the finance capitalism. The primary instrument these investors or other financial actors drew on was corporate bonds or stocks. Under the financialization, the grade of bonds and the value of stocks became the principal measures of corporate success and the means of value transfer. Starting with complete takeovers and corporate control to enhance 'market value' of corporations which was independent of their real productive or innovative success, the transfer continued in a more fundamentally through downsizing and distributing corporate resources and returns of productive activities (Lazonick and O'Sullivan, 2000).

The discourse of returning the value back to shareholders was not only asked by academics or by institutional investors. Together with the orientation towards finance to foster value, specific actors like business or securities analysts further articulated the shareholder value and asked for fundamental changes in corporate strategy like selling off unrelated assets to the core business and shifting investment decisions (Froud et al., 2006; Zuckerman, 2000). Some of them even gained executive positions to convince insiders to adopt their strategies (Fligstein, 1990). In early 1990s shareholder value was eventually specified as the capacity to meet security analysts' profit projections (Dobbin and Zorn, 2005). In describing the identity building efforts of these groups through narratives, Hansen (2014) says:

> *"At least part of what made the financial sector's rent-seeking activities successful was the narrative that enabled vested interests to perform a cultural capture, where decision-makers, analysts, and many others came to see the world in the same way as the financial industry. The result has been that policymakers and regulators have not lived up to the public's expectations that finance would be properly regulated". …*

To him, narratives are defined as:

> *"[Narratives are] important instruments in this development because they co-construct and legitimize regimes by framing the way we see the world. Narratives are not author-less discourses, but represent specific, powerful interests and make cultural capture by the financial sector of the political system possible".*

These narratives, in effect, have been co-authored by stock-market analysts, business journalists and even by company CEOs (Froud et al., 2006). Key to them, some terms and indicators to be understood by the financial community as a whole.

5.3.3 Reign of ratios – formulas of value maximization

Beginning with 1990s, shareholder value and value-based management gained its full strength in the US and the UK. To form up a common language and to easily compare restructuring corporations, consultancy firms introduced their proprietary value metrics to measure the performance of a firm that may give insights for rapidly growing institutional investor community to provide them with a story of purpose and achievement. In the meantime, value management was complemented with corporate governance tools to control managers so that they pursue shareholder value (Froud et al., 2006) as the requirements to solve agency problems. The most commonly used metrics and ratios have been Economic Value Added™, Return on Net Assets, Return on Capital Employed and Earnings per share. The last one is also used intensively to set targets for executive compensation and encouraged further the management to implement larger share repurchase programs in order to improve its value. Executives themselves consider that EPS is the most crucial measure in financial reporting and they are ready to forgo costly investments in order to deliver higher EPS figures (Christensen et al., 2008; Graham et al., 2006).

As a result, the performance of companies all over the word is evaluated today with a handful of profitability and market ratios that measure companies' success to use their assets to generate returns. The aim of a public company is to boost earnings while protecting the interests of shareholders in the form of valuable stocks and necessary returns in the form of dividends and share repurchases. Indeed, when the corporate success has been attached primarily to the share price performance, the primary role of stock markets became to deliver returns in the forms of dividends and share repurchases to principals. Such actions were accompanied with the rise in stock options and other share-based compensation methods.

5.3.4 CEOs as principals

When the rhetoric of shareholder value married with the corporate downsizing and distributing activity, the stage was also set for corporate executives. From now on corporate productive activities had to be aligned with the ultimate aim to maximize shareholder value and to deliver it. However, it was still managers' duty to establish this alignment as long as they continue to hold strategic control and related decision making power over their corporations. For the mainstream principal-agent problem of shareholder value this was a paradox (Boyer, 2005) because the suggested monitoring mechanisms and incentive compensation policies to solve the problem failed to prevent executive entrenchment and excessive pay awards. On the contrary, the aim of alignment made firms award their executives with much greater compensation packages (Shin, 2012). As a result, with a massive shift from salaries to stock options, executive pay has risen exponentially (Boyer, 2005; Lazonick, 2014b; Martin, 2003; Shin, 2012) suggesting that 'the power of managers has been more significant than the power of financiers' (Boyer, 2005, p. 40). 'They are politically savvy and resourceful enough to align their rhetorical positions and material interests with the new dominant discourse of the time'. (Shin, 2012, p. 555).

Managers themselves became the major proponents of shareholder value and offered generous stock-based incentive packages in exchange of their critical service in corporate resource allocation and generating competitive advantage. At the end it was 'a marked shift in the strategic orientation of top corporate managers in the allocation of corporate resources and returns away from ‘‘retain and reinvest’’ and towards ‘‘downsize and distribute’’’ (Lazonick and O’Sullivan, 2000).

5.3.5 The impact on expectations, culture, everyday life

In the era of maximizing shareholder value, the success of a company is tied practically to its financial performance measured through increasingly metrics like quarterly earnings per share and the constant distribution of these earnings to its principals. Short-termism, however, is not only pertaining to executives. In pursuit of short-term gains, shareholders steadily load and unload their portfolios as long as they have no reasons to be concerned with the value-creating success of the companies (Crotty, 2003). In return, companies should disgorge the cash to the shareholders through dividends and share repurchases diverting resources away from investments whose shareholder return is beyond the immediate horizon (Christensen et al., 2008; Salento et al., 2013).

Short-termism or the changing perceptions over time and objectives are not restricted to corporate world. Throughout the period financial services were offered to groups who had no connections to elites living on stock market appreciations or other forms of financial returns (Erturk et al., 2007). The efforts of a diverse group of intermediaries to establish links between these groups and global financial markets have gained multiple forms and actions (Erturk and Solari, 2007). It became rather a cultural process driven by narratives that reshape social reality in line with the ideas of Wall Street and its collaborators which shaped the world in its own image by spreading the narrative of efficient markets, meritocracy and shareholder value (Hansen, 2014).

5.3.6 Institutional & organizational change accompanied

Financialization is linked to a wide array of changes in modern capitalism in the last quarter of the twentieth century and it cannot be considered to be independent of accompanying institutional and organizational changes within capitalist economies. But the idea, as the main aim of this thesis, should be a co-evolution of financial, institutional and organizational transformations rather than one’s power imposed on others even though the bulk of the literature over financialization starts with the change within the sphere of finance and its implications over other domains. Even though the great majority of these studies start with the changing and ascending role of finance, there is still a need to shed light from different angles to highlight the accompanying rather than the determining role of finance. Fortunately, there is a considerable research effort that help to understand these underlying links between financial, institutional and organizational transformations.

Organizational changes of corporate capitalism accompanied with financialization have not only had an impact on the structure of internal organization of firms. To foster shareholder value, corporations have to boost their profits to be distributed later in the form of dividends and share repurchases. In that respect, from a mainstream perspective, the age-old aim of profit maximization and increased competitiveness through the search of cost reduction opportunities is given a new momentum (Bryce and Useem, 1998). As a result, outsourcing and offshoring became integral parts of corporate business strategy beginning with transnationals but followed by small-scale firms as well. Increasing their profits with lowered costs through offshoring and international outsourcing, globalization of production also helped Western corporations to reduce the need for domestic reinvestment of profits, freeing earnings for financial transactions and raising shareholder returns (Milberg and Winkler, 2010). Shifting bigger parts of production risks and investment needs to suppliers, outsourcing and offshoring through enlarged global value chains are increasingly justified by shareholder-value ideas remanufactured at the corporate headquarters (Froud et al., 2014; Milberg, 2008; Sako, 2005; Sturgeon, 2008). The inter-firm dynamics have been adding further pressure on suppliers which are usually small and medium size firms to follow similar financial rationale. In the end, the entire value chain has to lean on similar 'financially oriented rules' (Salento et al., 2013).

Such a direct link between shifting business strategies and changing financial motives renders industry and firm-level research highly valuable because it explores how firms reshape their productive organization through financial expectations and vice versa. However, also due to the lack of firm-level data on the monetary values of offshoring activities, their growth, and the extent of benefits they bring compared to the possibility of maintaining those same activities in-house, it is possible to quantitatively estimate the correlations among outsourcing/offshoring, earnings growth and shareholder value distribution. The increasing share of outsourcing in total costs can either be explained through rising outsourcing to suppliers or the productivity gains at home which reduce the share of internal labor costs.

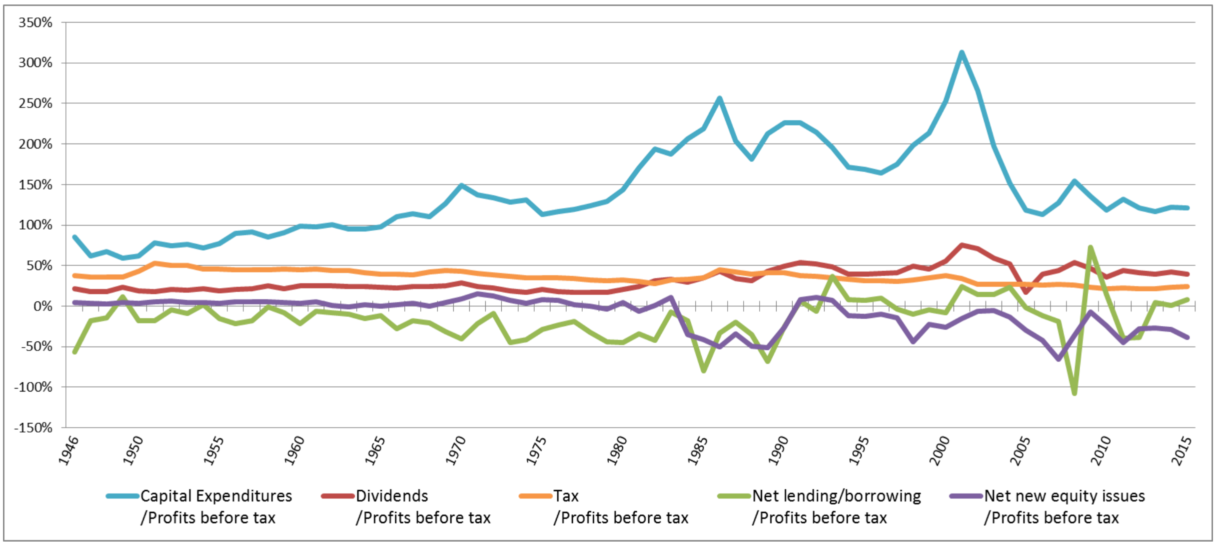
Moreover, qualitative correlations between in-house and outsourced work refer to the difficulties of estimating the separate sources of productivity gains that result in higher earnings, especially given the limits of existing accounting methods to measure such gains.

As stated earlier, a major impetus to financialization was the shift in management strategies from 'retain and invest' to 'downsize and distribute', especially in the US context (Lazonick, 2015a; Lazonick and O'Sullivan, 2000). The shift brought about an integral impact on the corporate governance with important implications for labor and employment (Lippert et al., 2014). Corporate restructuring, downsizing and all types of cost reduction efforts originally stemmed from this shift, rationalized by shareholder value ideology (Batt and Appelbaum, 2013; Froud et al., 2000; Fligstein and Shin, 2007; Salento et al., 2013; Thomson, 2003). Disconnected from established practices of industrial relations, the focus of corporate management has shifted towards the interests of shareholders (Thomson, 2003). This disconnection has had substantial implications on the incentives for the management to invest in skills and capabilities of their labor force, to engage in productive labor-management relations (Batt and Appelbaum, 2013). A growing body of research suggests a strong link between the emphasis on shareholder value and downsizing, restructuring and the gains of management over the rest of the workforce among US and UK firms (Froud et al., 2000; Goldstein, 2012; Jung, 2012) while their respective governments increasingly promote an 'equity culture' and equity ownership (Dore, 2008). In the case of continental Europe and Japan, the impact of the shareholder-value perspective on the corporate governance and to some extent labor-union policy has been elements of social compromises, but, except in the UK, this impact was still limited at the beginning of the century (Dupuy and Lung, 2002; Jacoby, 2008; Jürgens et al., 2000).

As a summary of all these transformations represented in financial figures, Figure 5.1 provides the uses of funds represented in earnings before tax by non-financial corporations in the period after the World War II in the US. There is a marked shift in the early 1980s from the general trend. Even though capital expenditures had much higher levels compared to previous period, since the second half of 2000s they returned back to the level in 1970s. What is completely different from the period before 1980s is the persisting net negative values of new equity issues. This means that since the early 1980s, it is the corporations which funded the stock market through share repurchases in total, not the other way around (Lazonick, 2015a).

Again beginning with the 1980s, the proportion of dividends to profits before tax shifted upwards from ratios below 20 percent to the ones over 40 percent and as a form of finance net lending on average is insignificantly low since the early 1990s. The ratio of tax to profit before tax also reached historic lows in 2010s.

Figure 5.1: Selected Figures of Nonfinancial Corporations in the US (Table F.102) as a proportion to total corporate profits before tax, 1946-2013



Source: Historical Annual Tables of Flow of Funds, Financial Account of the United States

5.4 Finance of innovation vs. Finance of shareholder value at Airbus and Boeing

Contrary to the mainstream views and their application over last three decades, innovation and technology development require long-term commitment of all stakeholders who should collectively benefit from the returns to innovation in the form of goods and services with superior quality and lower costs.

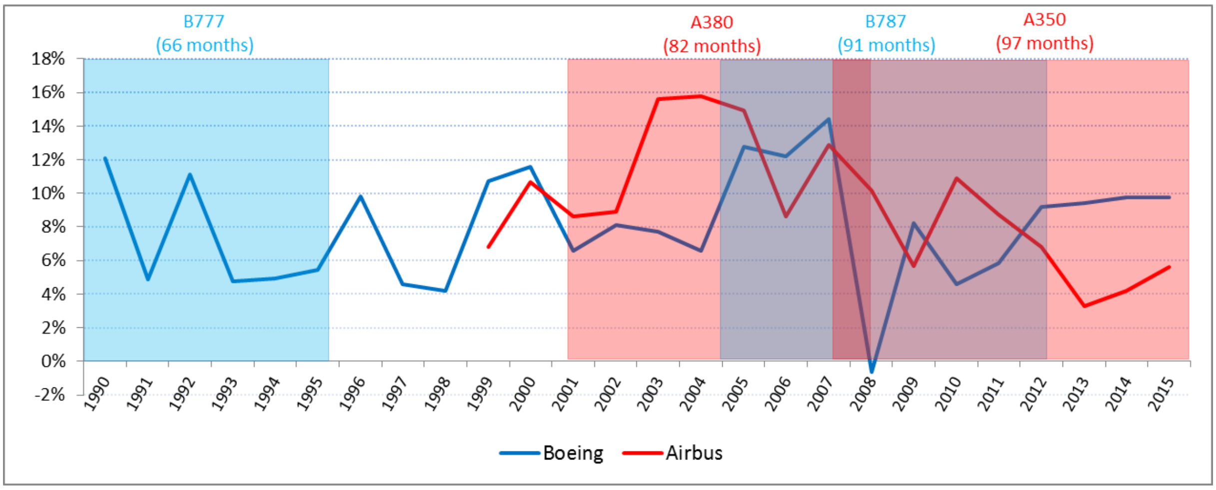
5.4.1 Sources of finance for innovation

For a large corporation in global capitalism like Airbus or Boeing, the decisions on new product development and accompanying efforts over innovation process and productive reorganization do not just depend on the magnitude of internal and external funds and the control over them. The choices of decision-makers to retain corporate resources for reinvestment in innovation or, alternatively, distribute cash to shareholders are also decisive. The reconfiguration of these choices has had direct implications on the production processes and related business strategies of manufacturing industries all over the world. As stated, corporate decisions which are primarily concentrated on cost-cutting and organizational restructuring have become integral to maximizing shareholder value ideology. Therefore, in order to understand the strategic orientation towards systems integration of Airbus and Boeing from the perspective of the association of financial commitment and strategic control, it is necessary to interpret the repercussions of this perspective on the commercial aircraft industry.

The analysis should now focus on the commitment of stakeholders to invest in the development of productive resources and their utilization, and the distribution of returns from innovation among stakeholders by the executives who retain control over these returns.

In commercial aircraft manufacturing, financial commitment is primarily about providing substantial amount of funds necessary to develop a new aircraft model which starts with preliminary conceptual design stage and may last until the point where, by attaining a large market share, unit costs of each aircraft become low enough for the profitability of the program. For companies large enough to be profitable in a sustained way like Airbus and Boeing, the primary source of finance is the retained earnings which are being generated through existing profitable programs. Shown in Figure 5.2, the operating cash flow of Airbus and Boeing is an indication to generate sufficient cash flow to maintain their operations including research and development and employment of its productive labor force more generally. Except for Boeing in 2008 due to substantial increase in inventories driven by the 787 program, a consistently positive OFC to Sales ratio is observed for both firms during the periods when they were developing their wide body aircraft, helping them cover a large part of their investment costs.

Figure 5.2: Operating Cash Flow as a proportion of Sales at Airbus and Boeing



Source: Company annual reports

For public companies, another form of internal finance can be the capital increase through share issues. However, large industrial companies generally do not finance their activities by selling newly issued stock. To the contrary, in the last three decades, these corporations have funded stock markets through their share repurchases to be discussed below. In the case of Airbus and Boeing, except Airbus' IPO in 2000 with a limited amount of common shares issued (a capital increase of only €1.5 billion), their equity finance is negative for the last 15 years. Hence any discussion that these companies require equity funding to finance innovation is groundless.

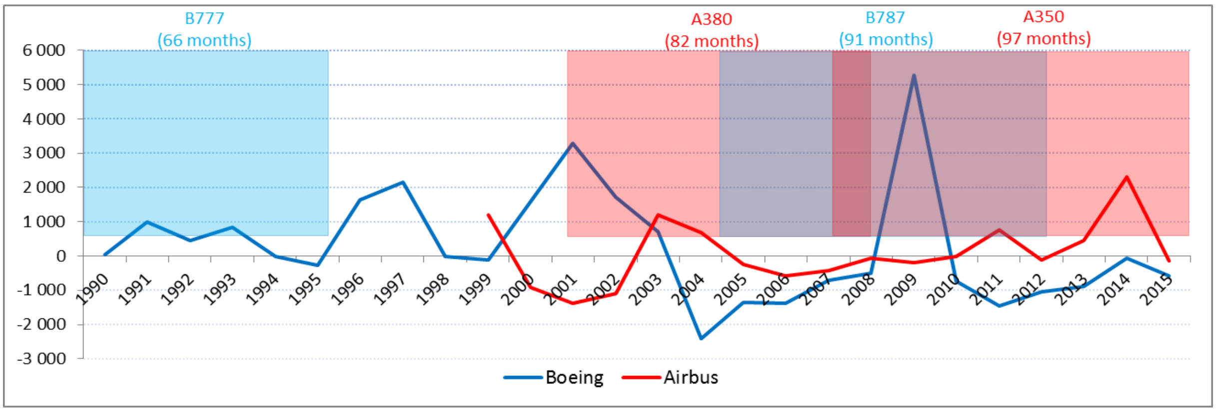
Big or small, business firms may also resort to loans to finance their investment and other related activities until they reap the returns of their investment and pay back their debts Moreover, within the context of financialization, debt finance until a certain level was proposed as a disciplining measure for managers to focus on maximizing shareholder value (Batt and Appelbaum, 2013; Froud et al., 2000; Jensen, 1986) although a high level of long-term debt compared to capital invested may also have a negative effect on investment as it increases financial fragility (Orhangazi, 2008).

For very large firms like Airbus and Boeing, the need to finance their investments through long-term debt may sound logical considering the substantial amounts of funds needed to finance new product development during a program. In Figure 5.3, the year-to-year changes in long-term debt of Airbus and Boeing are compared. Contrary to the reasoning that these two firms might have been full debtors especially during the early years of new product development, except the period Boeing developed its 777, both companies have been net payers of their existing debts while they were developing their airliners and burning big amounts of cash for their capital and R&D expenditures. For Airbus, the year-to-year change in its long-term debt is negligible for any production-related reasons even though the company resorted to European Investment Bank in its earlier programs which can be discussed under government support as these loans were criticized for being allocated at favorable terms. Only between 2011 and 2016 did the company receive €1.6 billion from the bank primarily to fund its R&D programs[51]. Beside EIB loans, the company has continuously received government refundable advances for its development programs on a risk-sharing basis, paying them back from its revenue-generating programs with interest on pre-agreed rates. These loans have to be repaid to the home-country governments according to the success of the project. In the case of A340, its only unsuccessful program in terms of these advances, the company settled €406 million with respective governments in 2011, directly resulting in increased operating income (+€192) and net interest results (+€120) in the same year. In 2013 (the last year Airbus detailed its European government refundable advances), A380, its double-decker which is still below the breakeven point, had refundable advances outstanding amounting to €3.6 billion to be repaid in the years ahead, if the A380 does not share the same fate (or worse) of the A340.

For Boeing, the periods when it increased its debt were actually the years of instability due to different non-innovation reasons including merger-related expenses (1996 and 1997), abrupt declines in demand and inventory build-up (between 2000 and 2003), and delayed advance payments and mounting penalties for 787 to customers and suppliers (2009). As analyzed in Chapter Two, a major part of R&D finance of Boeing comes through unpaid/cancelled federal and state-level income, utility, sales and property taxes, NASA and DoD research contracts and capital expenditures sponsored by state governments.

[51] "EIB reinforces its support of Airbus Group's innovation programmes", EIB Press Release, March 8, 2016

Figure 5.3: Year-to-year change in long-term debt for Airbus and Boeing, current US$ in bill.



Source: Capital IQ[52]

5.4.2 Use of finance generated by innovation

If the aim is to create value through financial commitment to fund required expenses and investments for innovation, the creation has to be complemented with the distribution of its returns to the parties who have committed their resources. However, when value creation is reduced to shareholder value creation in a financialized corporation, the ultimate aim of a public corporation is also equalized to maximizing shareholder value (Mauboussin, 2010). Beside stock price appreciation to increase capital gains, two main forms of maximizing shareholder value are the distributions in the form of dividends and share repurchases. In the last 20 years, especially in the United States, share repurchases became 'systemic and massive' and together with dividends they reached more than 90% of net income among large US corporations between 2003 and 2012 (Lazonick, 2014a). In Europe, they were also intensified after regulatory changes in late 1990s and early 2000s facilitating the share repurchase activity of large European corporations (Sakinc, 2012). Figure 5.4a shows that the main form of shareholder value distribution in Europe is common and preferred dividend payments. The extent of stock buybacks in Europe is still limited compared to the US as is shown in Figure 6.4b. Shown in Figure 6.4c, large European companies distribute as much as US companies on average when share repurchases and dividends are added together. The

[52] Capital IQ provides harmonized numbers for financial values which are calculated through multiple items like long-term debt, free cash flow or EBIT and EBITDA. For comparison purposes, in cases where companies may calculate the value of the same item differently, Capital IQ numbers are used. In other cases, the values are directly taken from company annual reports

widening gap in 2014 can be explained by record high share repurchases by large US firms and the depreciation of euro against US dollar in the last two years.

Figure 5.4a: Mean Dividends of US S&P500 (427) and European S&P350 (298) companies

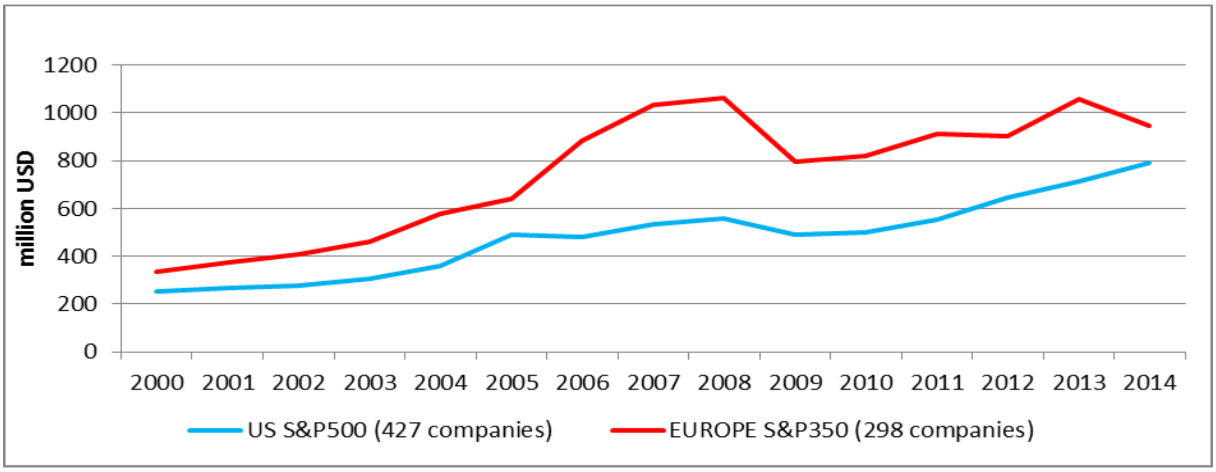


Figure 5.4b: Mean Share Repurchases of US S&P500 (399) and European S&P350 (302) companies

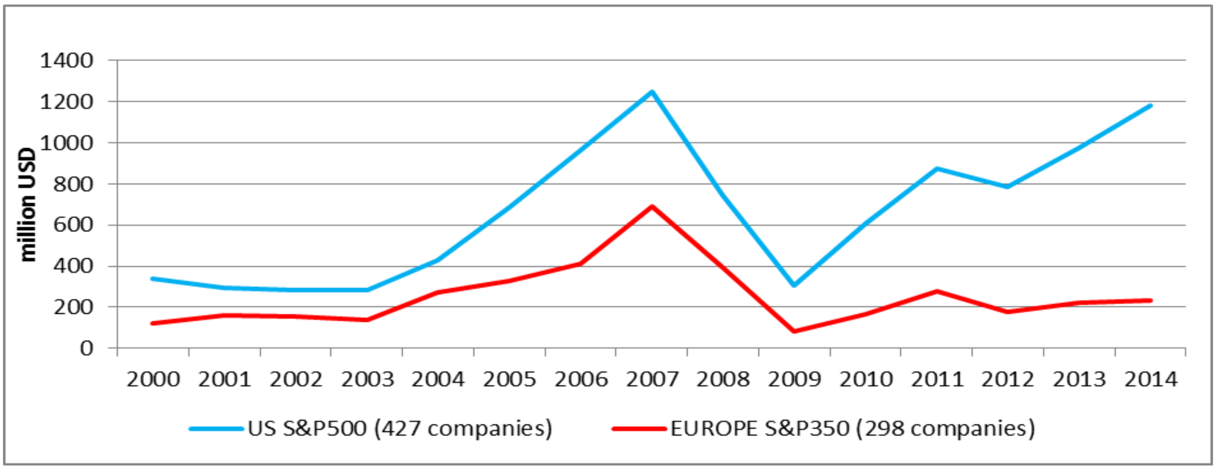
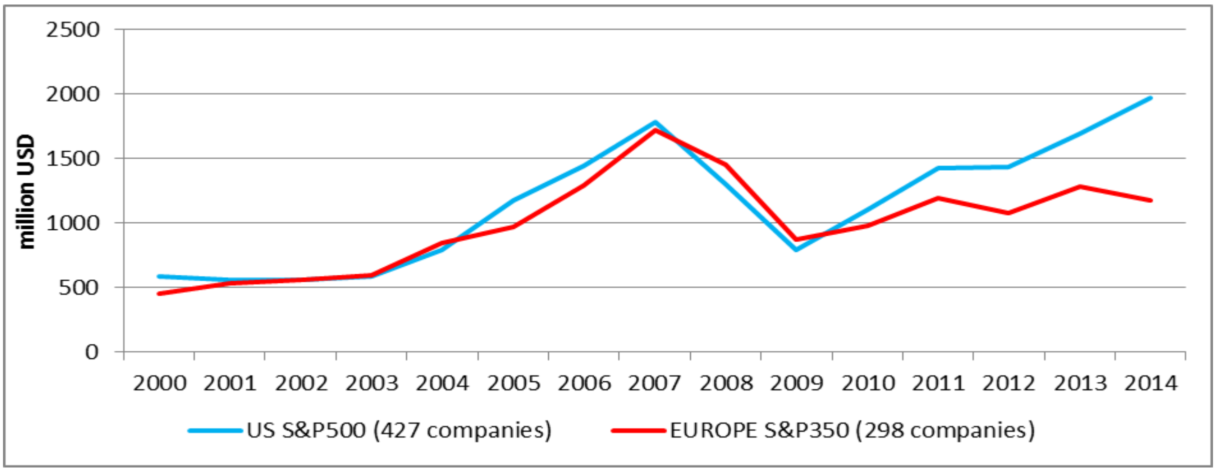


Figure 5.4c: Mean Dividends + Share Repurchases of US S&P500 (399) and European S&P350 (302) companies



Source: Compustat and CapitalIQ databases and company annual reports

Representative of financialized US corporations, in the last two decades Boeing has also distributed large sums of cash in the form of share repurchases and dividends while Airbus' distribution remained modest at least until 2013. As a proportion of cumulative net earnings in the period between 2001 and 2015, Boeing distributed 103 percent of its earnings while this ratio was 58 percent for Airbus also due to its not-so-unusual negative income figures in specific years during the same period.

Figure 5.5a compares share repurchases of the two firms. For Boeing it indicates three periods of mass repurchases interrupted with two intervals of industry level and economy-wide crises. The last period, however, dwarfed the previous two periods in terms of the amount spent on repurchases. In the last three years the company has spent $15.5 billion on share repurchases, more than half of the total amount of $29 billion spent between 2001 and 2015 (or 64 percent of its net income). Figure 5.5b compares two companies' dividend payments. Boeing is also a generous distributor of cash in the form of dividends to its shareholders. Between 2001 and 2015, it spent a total of $17.5 billion on dividend payments (or 39 percent of its net income) with an increasing trend. The same trend is also valid for dividends per share amounts since the late 1980s.

On the contrary Airbus' shareholder value distribution does not follow any specific trend except the gradual increase in its dividend payments in the last five years. Since its IPO in 2000, the company distributed limited amounts of cash in the form of dividends and share repurchases. In the case of share repurchases, up to year 2013, the total amount spent on stock buybacks remained below the amount obtained through capital increases and option and warrant exercises. Only in 2013, as a result of the shakeout in share ownership through the exit of strategic shareholders Daimler AG and Lagardère SCA and a reduction in state ownership, the company administered a large share repurchase program and spent more than $2.6 billion. In the same year an Airbus executive, for the first time in the history of the company, defined the creation of shareholder value as the centerpiece of company's strategy[53]. In May 2014, the board was authorized by the Annual General Meeting to repurchase up to 10 percent of company shares. The company started to buy its shares back only in late 2015. In addition to €264 million spent on share repurchases in 2015, the company

[53] "Hedge Fund Urges EADS to Sell Dassault Stake", The New York Times, August 5, 2013

spent another €320 million only in the period between January 1, 2016 and March 16, 2016. European Union regulations oblige companies to disclose daily amounts of shares repurchased and the amounts spent no later than the end of the seventh daily market session following the date of execution of such transactions (EC, 2003, 2016). The accounts of Airbus show that the company repurchased its shares on a daily basis since it started its buyback activity on November 2, 2015. Except on a small interval in the first week of March 2016, the company bought its shares back almost every single working day since November 2015. Airbus share price during the same period and especially in the last two months of 2015 reached a record high level. As discussed in the following section below, a late 2012 agreement among major shareholders and the board of the company has considerably changed the shareholding structure of the company. One of the most highlighted points by the CEO of the company was the intention of the company to launch a share repurchase program in the coming period.

Figure 5.5a: Share repurchases of Airbus and Boeing, current prices

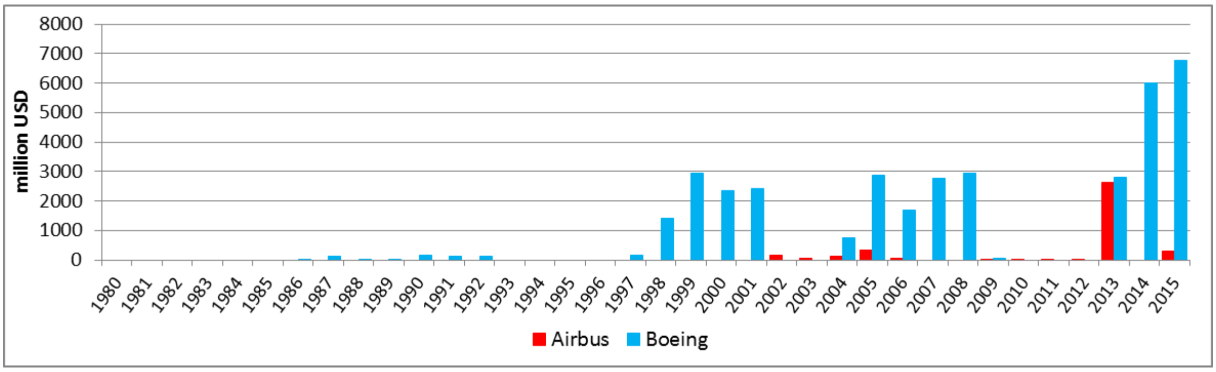


Figure 5.5b: Dividend payments of Airbus and Boeing, current prices

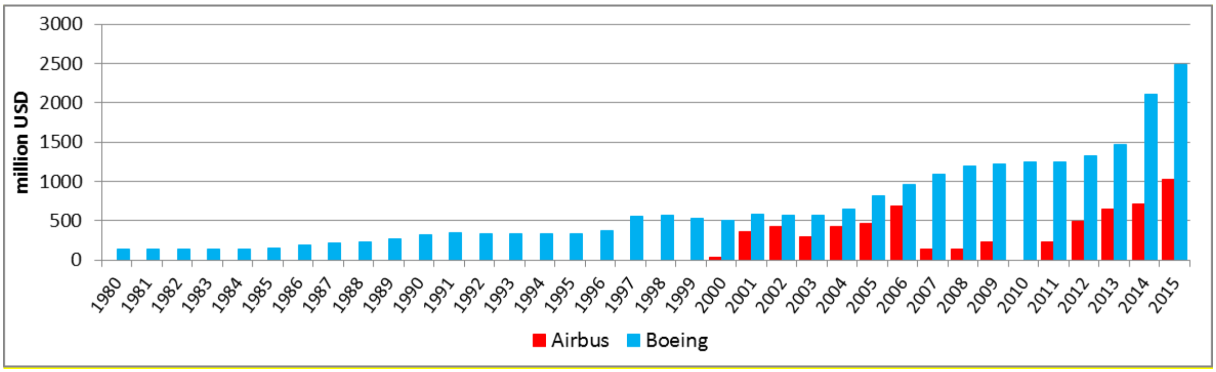


Figure 5.5c: Total Payout of Boeing and Airbus (dividends + share repurchases), current prices

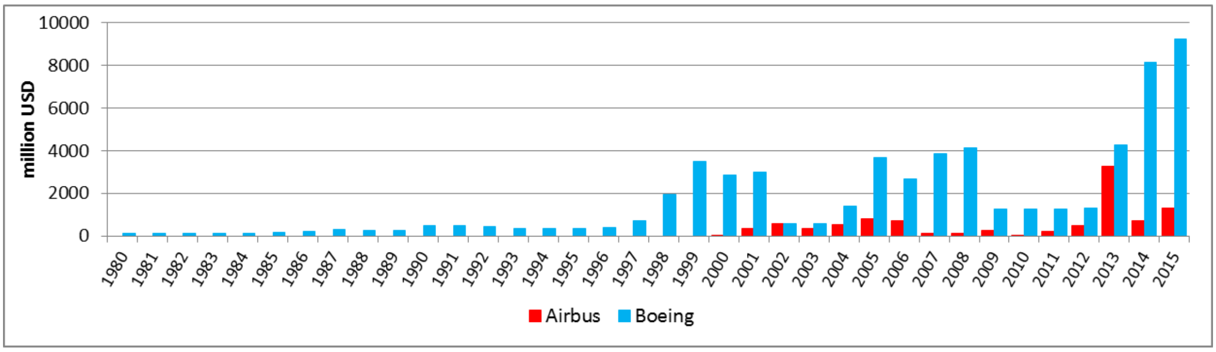
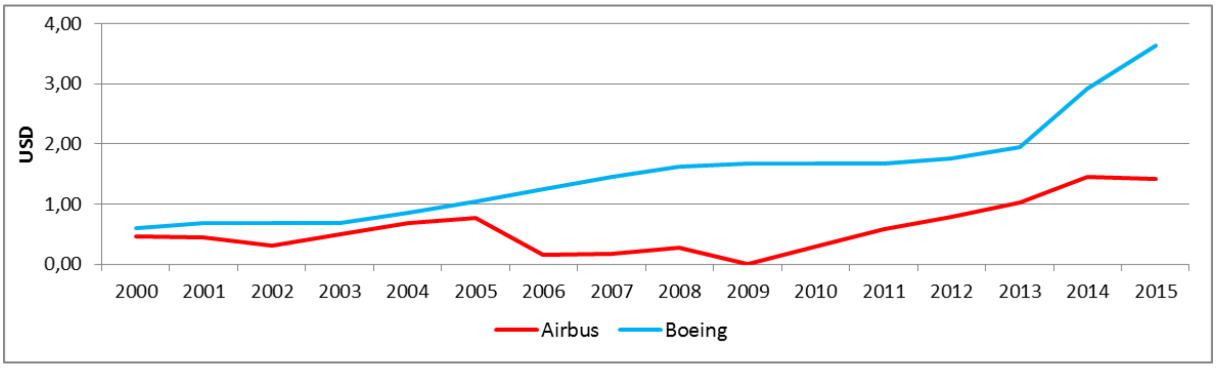


Figure 5.5d: Dividends per share of Boeing and Airbus, current prices



Source: Company annual reports

5.4.3 Share ownership structure and change

The fact that the sources and uses of finance are principally decided through corporate governance practices of public companies, the characteristics of their ownership structures should also be questioned. The conditions under which companies like Airbus and Boeing undertake uncertain and expensive investments in technological development are also conditioned by the demands of public shareholders.

To start with Airbus, the company had a momentous shareholder structure and governance change in 2013 after its board of directors and core shareholders agreed on it in late 2012. According to the agreement:

-Present shareholder pact expected to be replaced by a normal company governance scheme

-Daimler AG and Lagardère SCA to largely reduce their stakes, Germany and France intending to ultimately hold up to 12% each, Spain circa 4%

-EADS intends to propose a share buy-back of up to 15% of outstanding shares – subject to market conditions and shareholder approval

-Free Float of EADS shares should therefore ultimately increase from 49% to over 70%[54]

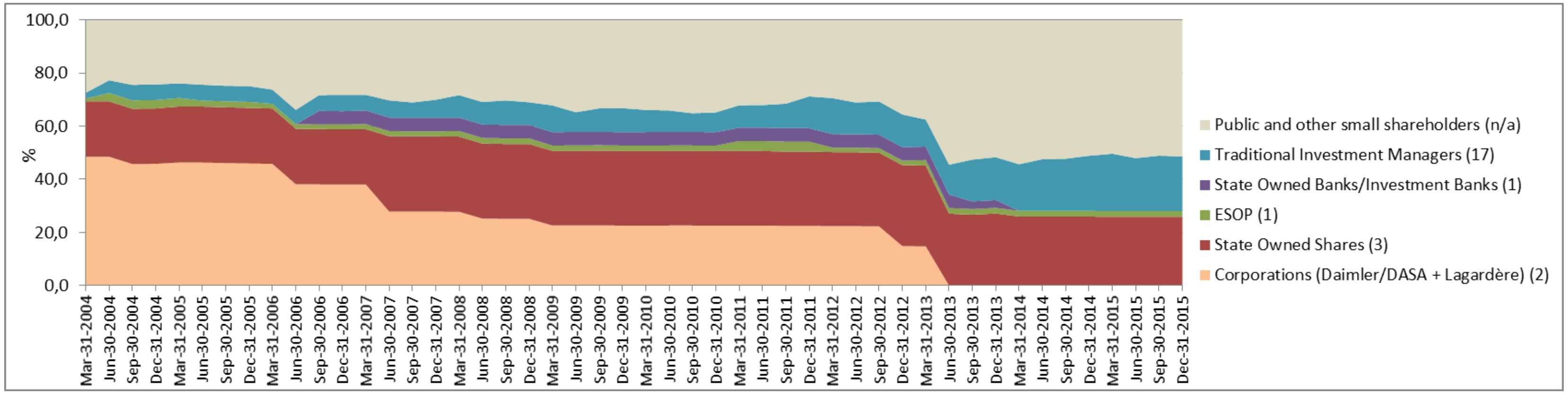
Figure 5.6a below shows the shareholder structure of Airbus during the period between 2004 and 2015. Following the agreement, these two corporations, Daimler and Lagardère exited the company by selling their entire shareholdings on the market and the government shareholding also decreased to some degree in order to comply with the percentage caps decided by the agreement. The agreement put an ownership and voting restriction from crossing the 15 percent threshold by any shareholder and more importantly, under the new governance scheme, no veto right is given to any group of directors or any shareholder individually or collectively. The French and German governments lost their rights to veto over strategic management decisions including acquisitions and launching new programs. Only certain rights of governments over national security interests are protected under the new scheme even though the governments will most probably continue to fund new product development efforts of the company as they always have. Such an important government function will also

[54] "EADS Governance and Shareholding Structure Receives Far-Reaching Overhaul", Airbus Press Release, December 5, 2012

have an influence on any decision over restructuring, investments across home countries, and reorganization of workforce.

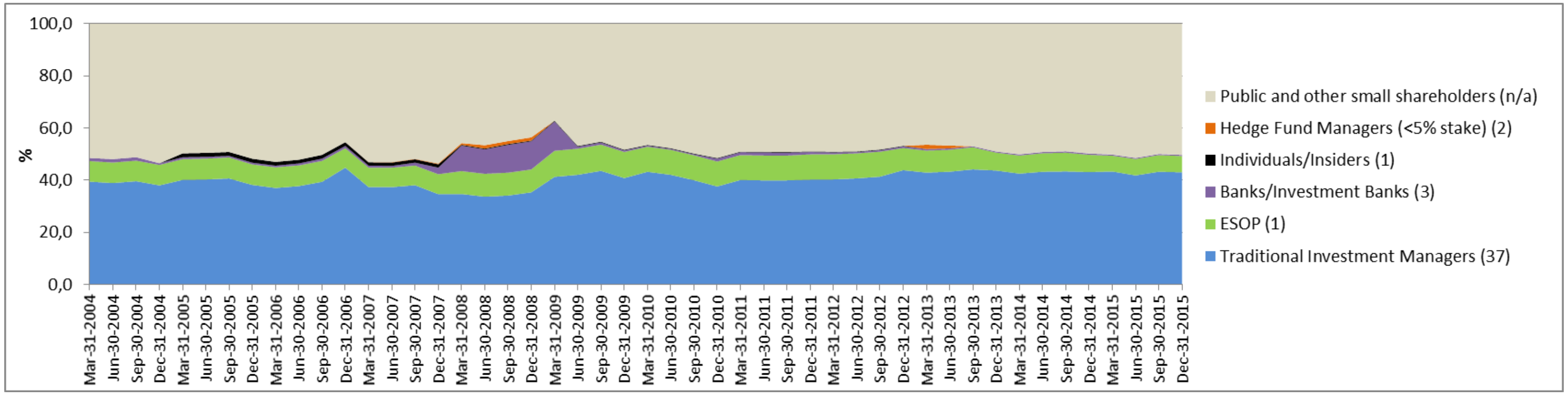
During the same period Boeing’s shareholding structure did not change very much. Ownership of parties holding one percent or more of Boeing shares oscillated around a combined total of 40 percent in the last 12 years. The company’s voluntary investment for employees has held around six to seven percent of company shares in the last years even though it increased above ten percent of total shares during the financial crisis. Other shareholder groups such as banks and hedge funds do not have significant percentages of company shares.

Figure 5.6a: Airbus shareholding concentration between 2004 and 2015



The categories other than 'Public and other small shareholders' represent the shareholders who held one percent or more of Airbus shares for at least one quarter since March 2004. The numbers in parentheses represented the numbers of shareholders in each category.
Source: Capital IQ.

Figure 5.6b: Boeing shareholding concentration between 2004 and 2015

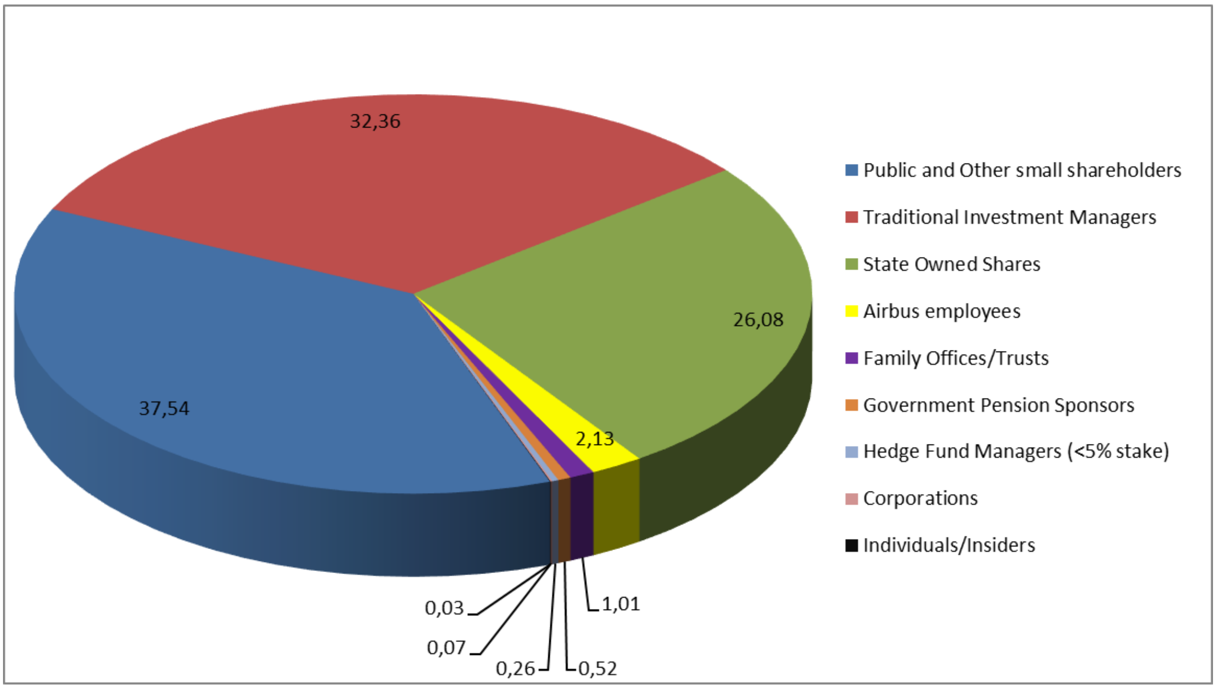


The categories other than 'Public and other small shareholders' represent the shareholders who held one percent or more of Boeing shares for at least one quarter since March 2004. The numbers in parentheses represented the numbers of shareholders in each category.
Source: Capital IQ

Figure 5.7a show that, as of December 2015, compared to 69 percent at the beginning of 2001, only 31 percent of Airbus shares are held by governments, employees and other insiders including executives and directors. The rest is held by a large group of small shareholders as well as other institutional investors. Figure 5.7b shows the large shareholders who hold more than one percent of company shares and the remaining small shareholders including general public. Immediately after the exit of strategic corporate shareholders in early 2013, traditional investment managers such as Capital Research and Management Company and Blackrock almost doubled their shareholdings. Many other asset managers who hold smaller amounts of Airbus stock also increased their shares in the same period.

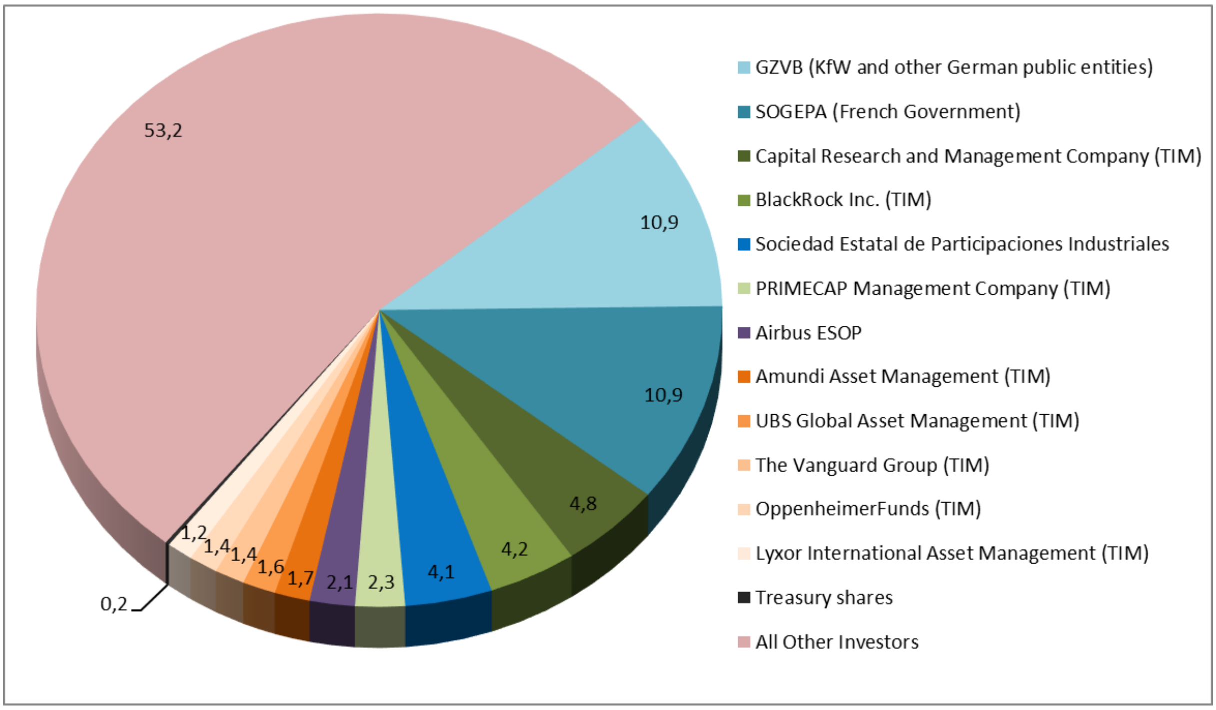
Figure 5.8a show that the dominance of traditional investment managers is also the case for Boeing shareholding structure. With over 60 percent of Boeing shares held by this group of investors in 2015, they constitute by far the largest shareholder group. As shown in Figure 5.8b, large asset managers such as Capital Research and Management, Blackrock, Vanguard and T. Rowe Price are also largely present among Boeing’s shareholders.

Figure 5.7a: Types of Airbus shareholders with their proportion in December 2015, in %



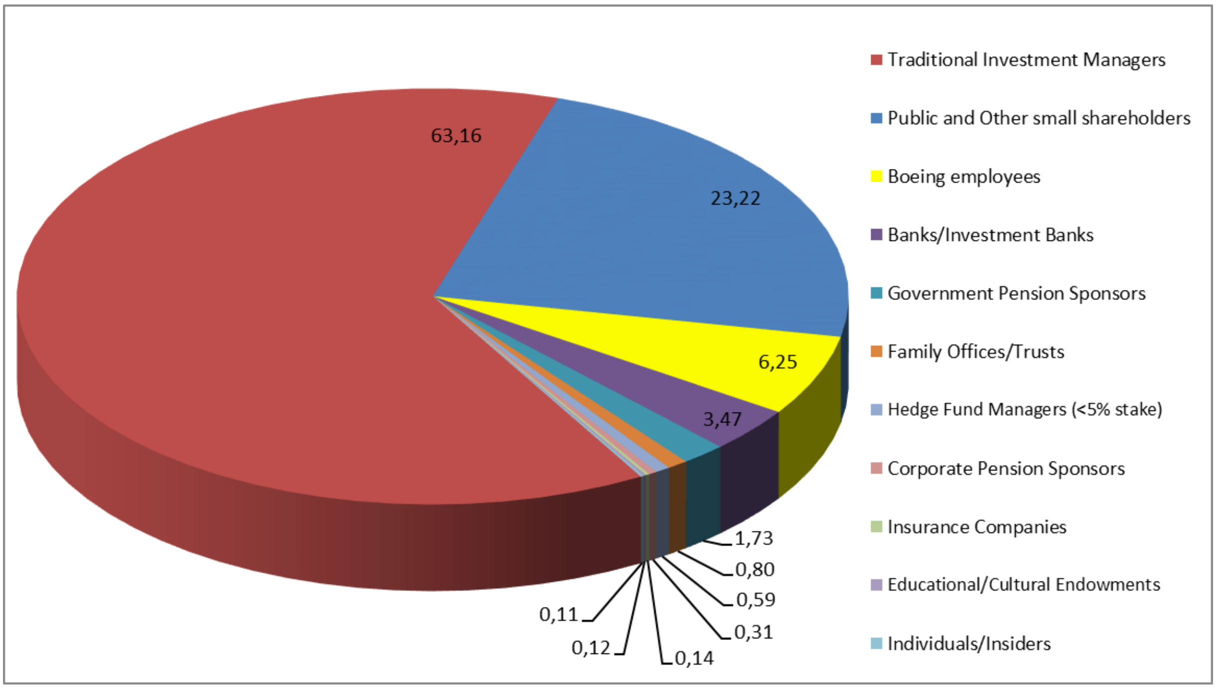
Source: Capital IQ

Figure 5.7b: Major shareholders (>1%) of Airbus in December 2015, in %



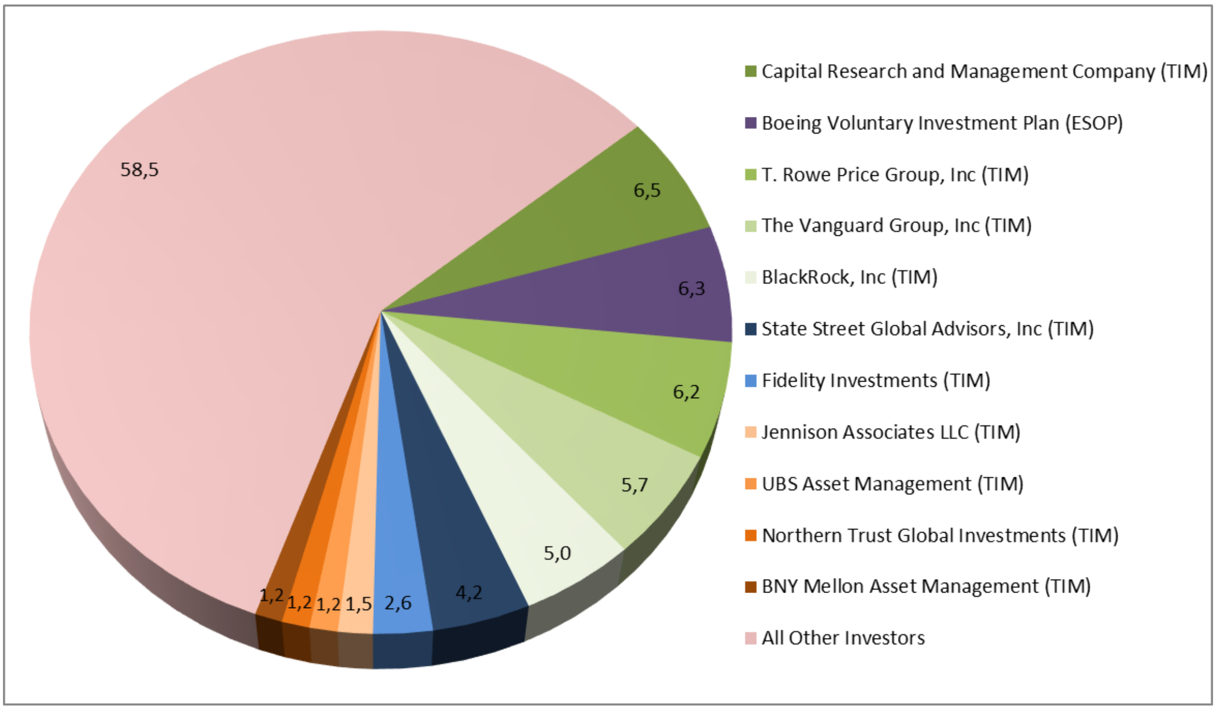
Source: Capital IQ

Figure 5.8a: Types of Boeing shareholders with their proportion in December 2015, in %



Source: Capital IQ

Figure 5.8b: Major shareholders (>1%) of Boeing in December 2015, in %



Source: Capital IQ

5.4.4 The functions of the stock market for Airbus and Boeing

The analysis so far has shown that in the case of Airbus and Boeing, the creation and cash functions of stock market formulated by Lazonick (2007) are not valid for either company. The creation function refers to the facility to provide finance for new ventures and the prospect of financial liquidity for financiers to exit at a later point in time. Even though Airbus did its IPO only in 2000, the main purpose was not to raise funds, and none of the companies issued shares on the stock market primarily to fund certain venture creation. The same is valid for the cash function of the stock market. Neither of the companies resorted to the stock market to fund their new product development efforts in the last 20 years.

Combination and control functions, however have different meanings for Airbus and Boeing. The Combination function enables a public company to use its own stock as a form of payment in mergers and acquisitions. Boeing utilized this function two times in its modern history when it acquired McDonnell Douglas Corporation and Rockwell's aerospace and defense business, the first and third biggest acquisitions of the company, by issuing company stock to replace the acquired companies' shares. During the same period, the company acquired five other companies with a value above $1 billion, using only cash. Airbus has never used this function in its history as a public company. The company, on the other hand, is exposed to the control function of the stock market. This function refers to the ability of the stock market to affect the concentration or fragmentation of shareholding by enabling the selling and buying of shares. As explained above, Airbus shareholding concentration has largely changed in recent years even though a board decision was still needed to agree on the change. Only after the agreement was signed did the shareholders act accordingly and sell their shares on the market. The change in control over the allocation of corporate resources was also decided by the agreement, with a limit of 15 percent on shareholding by each three governments and the cancellation of veto rights.

The last function of the stock market is Compensation, and it is the only function strongly embraced by both companies. It refers to the use of a company's own stock as a form of employee and executive compensation. Detailed in the previous chapter, stock options and awards have been increasingly used by both companies even though these modes of compensation are much more utilized by Boeing, not only for senior management and stock ownership plans but also for many of its employees and their pension plans. The following section details the executive compensation practices of two companies.

5.4.5 The compensation function and executive compensation of Airbus and Boeing

One major argument proposed by corporations to perform stock buybacks is to offset the dilution from exercising stock options which are disproportionately granted to top executives and other employees as a form of compensation and conditioned to financial performance of the firm. Granting stock options has a long tradition in the US. But its boom in the 1990s marked a new era of executive compensation principally based on company stock (Monks, 2005) and it supposedly helped to solve the principal-agent problem by aligning the interests of top management and shareholders. On the contrary, firms that appear to empower shareholder value by increased monitoring and incentive-alignment mechanisms pay systems, increased the CEO pay even more in the following periods (Shin, 2012). Moreover, the transactions and valuations are based on expectations of future real earnings and instead of providing an incentive for these managers to increase real earnings, stock-based compensation creates incentives to raise expectations of future earnings and then to sell the stock before expectations fall (Martin, 2003). Because so much of executive compensation comes from stock options, top executives have a strong incentive to take steps to avoid dilution of earnings per share, and can use share repurchases to offset dilution (Bhargava, 2013). Thus the stock options and stock buybacks are inherently interrelated. Because the earnings per share is one of the most important metrics used for company valuations (and also for the determination of executive compensation), stock buybacks become the most powerful tool to keep stock prices and executive compensation levels high. High stock prices inflated mostly through unrealistic expectations created by company managers and circulated by financial advisors motivate executives to exercise options and sell their stock at these higher prices while they also administer large-scale stock buyback programs. Consequently, expenditures on research and development and long-term investments have been negatively affected by stock options share repurchases due to the lower funds available (Bhargava, 2013). The relation between stock options and stock buybacks is also reflected in the difference between American and European corporations. According to an estimate comparing executive compensation in major corporations of the two sides of the Atlantic in the first half of 2000s, a top European executive holds options worth €1.3 million while the amount of options a US executive holds worth €18 million. Income of a top European executive rises around €85,000 as a result of a one percent increase in company stock price versus €2.2 million for a US executive (Muslu, 2010).

As a result, company executives and especially US executives have strong incentives to make decisions that have an impact on their companies' stock prices as share-based incomes constitute a large part of their total compensation. Through extensive utilization of stock options and stock awards for compensation, executives became less aligned to other stakeholders' interests and corporate productive success as their remuneration is mainly connected to financial success. Golden parachutes in the form of stock options and special retirement benefits show that they are becoming a distinct group who spend their time thinking about how to boost stock prices rather than keep the money and the people together to deliver new sources of value to customers (Lazonick, 2014a).

In the case of commercial aircraft manufacturing, Figure 5.9a shows that for Boeing, the total number of stock options and stock awards granted to CEOs averaged around 3 per mil of total number of outstanding shares on average between 2000 and 2013. The same figure is around 2 per mil for Airbus for the same period. Beginning in 2014, Boeing stopped granting stock options for its executives or employees and replaced them with performance awards for executives and performance-based restricted stock units for executives and eligible employees. Because of that, the 2014 grants only contain stock awards.

Figure 5.9b compares the exercise of stock options/awards and vested performance shares of CEOs during the same period. It shows that the exercise of stock options by Boeing executives is quite regular while Airbus executives have exercised their options only during the period of 2005 and 2006 which was actually the golden parachute for the outgoing CEO who was also accused of insider trading together with several other executives and previous corporate shareholders Daimler and Lagardère. In 2006 they sold their shares before the news of Airbus A380 delays was released but they were later cleared by France's stock market regulator.

The existing CEO of the company started to receive vested performance shares in 2010, and in 2013 and 2014 (after the shuffle in corporate governance), beside vested shares, he also exercised his stock options for the first time after the golden parachute exercises of the previous CEO.

Figure 5.9a: Proportion of stock options/awards granted to Airbus and Boeing CEOs

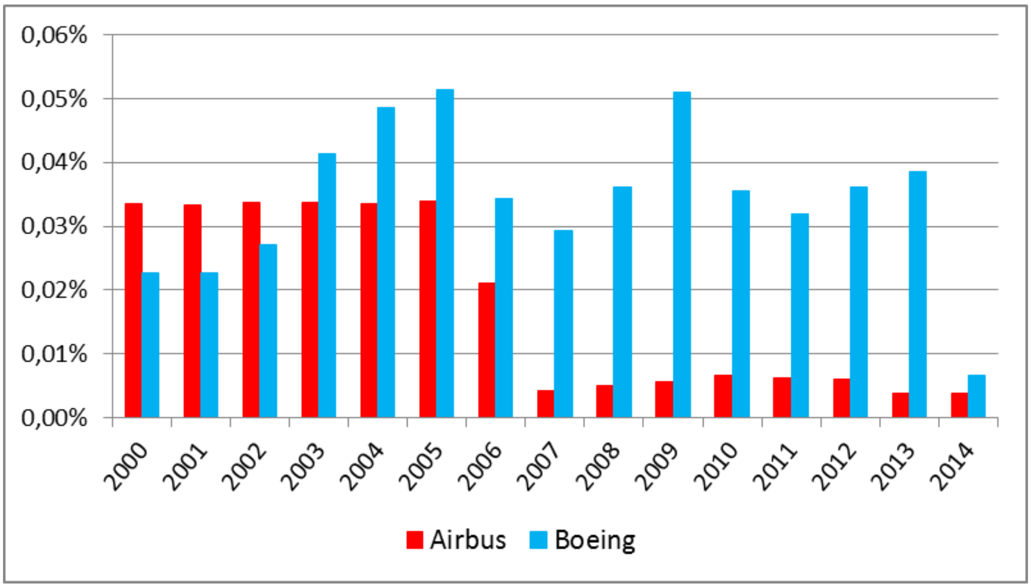
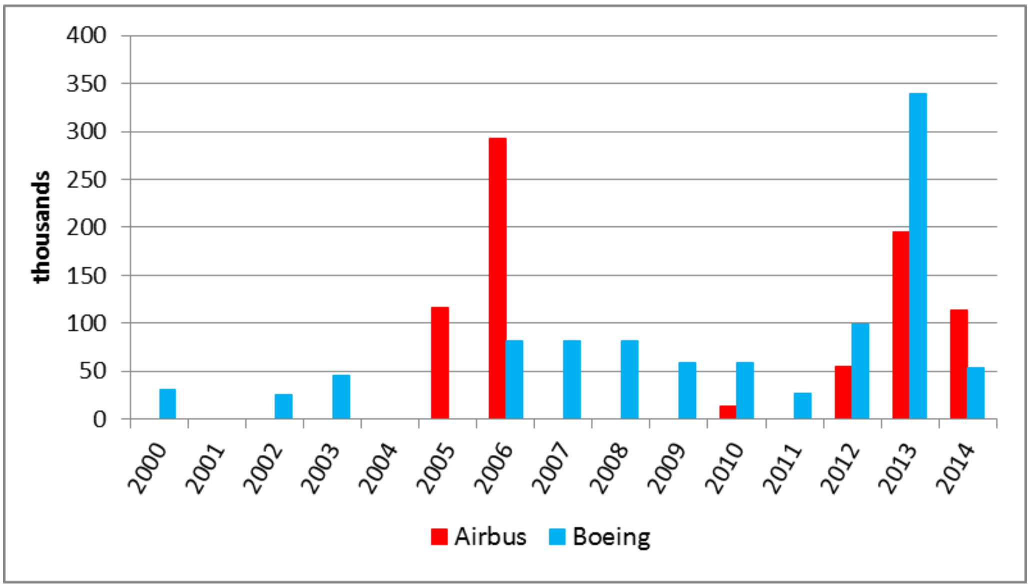


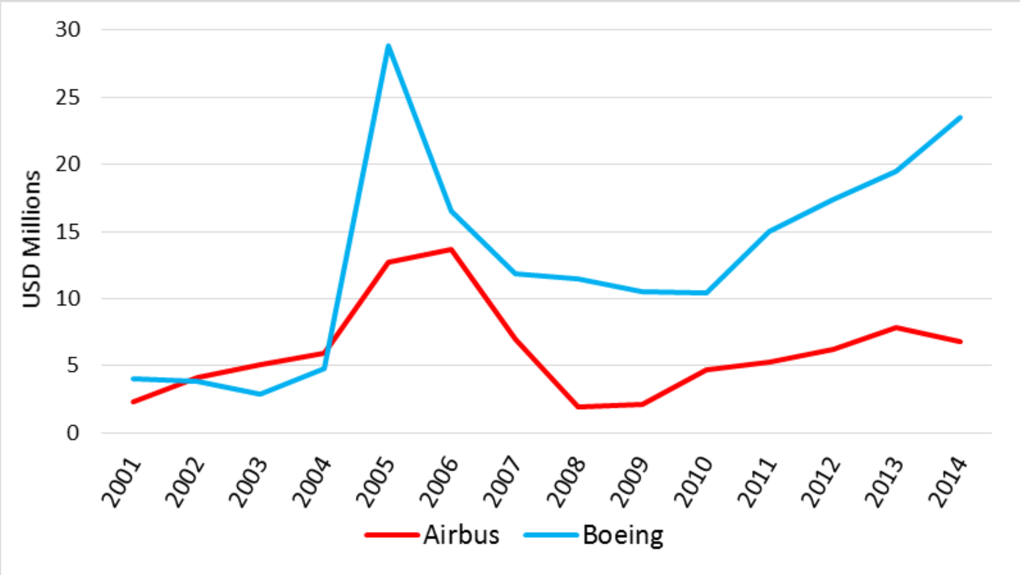
Figure 5.9b: Number of Airbus and Boeing CEO stock options/performance shares executed/vested



Source: Company annual reports and proxy statements

While it should be taken very cautiously because of very different rules and regulations of different forms of executive remuneration, Figure 5.10 compares the total CEO remuneration of two companies for the same period.

Figure 5.10: Total CEO remuneration for Airbus and Boeing



Source: Company annual reports and proxy statements

5.5 Conclusion of the chapter

This final chapter explored finance, the third component of the systems integration business/productive model proposed as an analytical framework of this study. Divided in two parts, the component was analyzed both through the two lenses of financial commitment, the first one that sustains the flow of funds required for new product development and the second one that pursues certain objectives that support or undermine the equal distribution of their fruits of the value created among stakeholders who participate in these efforts by bearing risk with their commitment.

In order to detail the transformation of the financial objectives and motives which increasingly prevent corporations from keeping their side of any bargain with employees (Thomson, 2003), the concept of financialization as a systemic transformation in corporate governance and business activity within capitalist economies was discussed from its different (but interrelated) aspects. Its discursive character together with the changing role of certain actors involved in decisions on financial orientations were discussed. Its impact on the expectations of other segments of the society was highlighted and related institutional and organizational changes at macro and micro levels were elaborated.

In the second part of the chapter, after identifying retained earnings and government support as the major sources of finance for innovation for Airbus and Boeing, their uses of finance were put under the spotlight. The impact of the shareholder value paradigm was examined through their shareholder value distribution practices in parallel to the practices being followed by other large firms of their home country/region. After mentioning the role of changing corporate governance forms and related ownership structures, the five functions of stock market (Lazonick, 2007) are compared and contrasted. Lastly, the compensation function was detailed by comparing CEO remuneration practices of two firms and the varying degree of stock based compensation practices is highlighted. An emphasis is underlined on convergence potential of two firms in terms of their shareholder value distribution and executive compensation practices.

Without any role attributed to the transformation of finance and work organization/industrial relations in executing these so-called systems integration strategies prevent any scholarly work from identifying distinct constructive and destructive processes of any integration/disintegration strategy.

The general results of this research show that there is a strong correlation between extensive outsourcing, financialization of business strategies and conflicting employment relations.

In the case of Boeing, while the company aims to reduce spending through outsourcing and increasingly conflicting labor practices, it has also extended its shareholder value orientation through dividends and stock buybacks and enlarged and diversified compensation mechanisms provided to executives and other high-ranking employees as means of value extraction. Financialization has deep roots in the company.

Compared to Boeing, Airbus has followed a balanced strategy, mitigating conflicting interests up until the present day. Despite the facts that it outsourced 50% of its latest aircraft program A350 and divested several business units as part of cost-cutting programs, the tension with the workforce and distribution of corporate cash to shareholders has so far remained under control. However, its most recent discourse and practices provides strong evidence that a more financialized business strategy is on the way together with ever-rising concerns of the workforce over job security.

General Conclusion

This thesis shows the interconnections between the three main elements of firm-level productive activity under modern capitalism, namely corporate strategy, organizational structure and financial commitment. The firm-level case studies in the thesis are Airbus and Boeing, the two biggest firms in the commercial aircraft manufacturing industry. Each productive activity is analyzed through the lens of the systems integration business/productive model framework developed in the first chapter. The latest transformations in corporate strategies, industrial relations, and financial actions of firms in advanced economies are briefly discussed before the application of the model framework to the two case firms through a comparative-historical approach. The study follows the work of Chandler (1962, 1977) and Penrose (1959, 1960) and more recently Froud et al. (2006) and Lippert et al. (2014) in presenting detailed historical accounts of business firms in action, in the form of a comparative case study laid out in its second part.

Through this approach, the study also identifies the industrial dynamics of the most recent restructuring of aerospace and commercial aircraft manufacturing industries. The process is in general slow but it is profound and in many of the cases irreversible, such as the loss of Russian or Dutch aerospace capabilities in the last two decades, with neither national industry reaching their previous levels of integrated capacity of aircraft production. Depending on the featured role of technological or political-economic factors, the great transformations within the industry like the introduction of the jet era after the Second World War or the consolidation of the global aerospace industry after the end of the Cold War are rare but decisive points in the history of aviation.

In contrast to the technology literature which understands systems integration as a new form of capability to address the development and production of more complex and high-cost products having a systems character in the sense that they involve multiple technologies and collaboration between a large number of organizations (Hobday et al., 2005; Prencipe et al., 2003), this thesis investigated systems integration as a business/productive model which has important strategic, organizational and financial attributes. The nature of the systems integration orientation of both firms in the last two decades not only defines their reorganization of R&D and production activities in technology intensive industries, but also has important organizational and financial consequences. With a conceptual framework based on the productive models approach of the Regulation theory and the theory of innovative enterprise proposed by W. Lazonick, this study identifies distinct constructive and destructive processes of integration or disintegration strategies followed by Airbus and Boeing, with important roles attributed to the new orientations in finance and work organization/industrial relations in executing these so-called systems integration strategies.

The results of this research show that there is a strong correlation between extensive outsourcing, financialization of business strategies and conflicting employment relations. Outsourcing more than 70% of its latest innovation program B787 and aiming to keep capital expenditures and R&D costs under control, Boeing has been exerting pressure on its employees through recurring layoffs, relocation and cuts in employment and post-employment benefits. Job security has become the most important concern of the workforce and the reorganization of new product development extends tensions between the management and workforce. While the company aims to reduce spending through outsourcing and tightening labor practices, it has also extended its shareholder value orientation through increased dividends and share repurchases as well as stock options granted to executives and other high-ranking employees as means of value extraction. Financialization has deep roots in the company. Compared to Boeing, Airbus has followed a balanced strategy, mitigating conflicting interests up until the present day. Despite outsourcing 50% of its latest aircraft program A350 and divesting several business units as a part of its cost-cutting programs, the tension with the workforce and massive distribution of shareholder value have so far remained under control. However, its most recent discourse and shareholder value distribution practices provide some evidence that a more financialized business strategy is on the way. The concerns of the workforce over job security are also on the rise.

Evidence detailed throughout the study suggests that systems integration *à la* Boeing and *à la* Airbus are harmful to their long-term competitive capabilities, and neither of them is immune to the perils of financialization and deteriorating employment practices. The future course of their actions will have important implications for the future of aerospace and commercial aircraft manufacturing in their home countries.

Summary of the Findings

The introductory chapter laid out the structure of the thesis with the identification of the general problem addressed, how and why the comparative analysis of Boeing and Airbus was chosen, the theoretical approach that has been deployed, and the methodological positioning with an argument on how a comparative historical perspective integrates theory and history.

The first chapter provided the general theoretical perspective utilized for the industrial and firm-level analyses performed in the following chapters. Innovation was identified as an organizational engagement that should be described in terms of the emergence and diffusion of different organizational forms of productive activity and their corresponding management forms. After a brief discussion of the organizational foundations of innovation highlighted by the economics and business literature of the last twenty years, organizational capabilities were identified as firm-specific enablers of innovation. To develop and employ these capabilities, the business enterprise, the main actor of productive activity in modern capitalism, requires a framework for generating a surplus and reinvesting or redistributing it. The process has to be identified through a certain methodological perspective and in the following sections of the chapter, the business literature and productive models framework of the Régulation school were identified in order to construct an analytical model to be used for the case study research in the second part of the thesis. With the help of the theory of innovative enterprise developed by W. Lazonick, the systems integration business/productive model was proposed as a specific way of interaction of certain generic activities in commercial aircraft manufacturing during a specific period which becomes the dominant pattern for business activity at the global level.

At the end of the chapter, the historical course of systems integration as a productive activity and its capability-based discussion made by technology scholars were discussed. Finally, the reasoning for the proposition of systems integration as a business/productive model was explained, and the general research framework was presented.

The second chapter was focused on the industrial characteristics of aerospace and commercial aircraft manufacturing and their evolution. After a brief description of the industry and its major actors in terms of their growth dynamics and shareholding structures, with remarkable similarities and differences between these actors in distinct geographies, the main features of the industry were discussed with a focus on the latest transformations at the industry level, with detailed descriptive information provided. The last section of the chapter is devoted to the role of government support as a dominant feature of aerospace and commercial manufacturing, fully influential in the emergence and the growth of the industry throughout the world. After a brief historical background of the role of government in the development of the aerospace and commercial aviation, the rest of the discussion was focused on trade conflict in commercial aircraft manufacturing between the US and Europe since the 1980s. The US and EU governments and their top aerospace companies Boeing and Airbus have long been blaming each other for providing and receiving large amounts of government subsidies, some part of which have been proven to be illegal by the WTO after an investigation which lasted more than ten years. It was shown in this chapter and in the next part of the thesis that, despite these WTO-level decisions, both companies continued to receive subsidies in a quantitatively and qualitatively increasing manner. The current subsidies provided by different forms of government not only have provided larger amounts of funding in the context of ever increasing costs of product development programs, but also have taken multiple forms in helping firms to sustain their productive activities and increase their competitiveness.

The second part of the thesis was devoted to discussion of the three fundamental elements of the systems integration business/productive model of Airbus and Boeing. Each one of three chapters focused on one pillar of the model embraced by the two firms, with marked similarities and differences.

The third chapter of the thesis was on the comparison of the strategy component of the systems integration model at Airbus and Boeing. It provided a detailed overview of the corporate strategies of the two firms with a focus on their latest product development programs. The comparisons on the two companies' knowledge bases, investments, expenditures on research and development, and collaborations with other actors of aerospace and commercial aircraft manufacturing show that the systems integration and focusing on core competences strategies are switched on and off as they are determined by the companies' broader aims that can only be analyzed within a business/productive model framework. The companies usually extended their knowledge base beyond their core competencies in line with their corresponding capital investments. There is equally relevant evidence of integration and disintegration continuously shifting their boundaries.

Nevertheless, there are marked differences between the two companies such as greater global extension of Airbus in the form of joint ventures, research and technology centers compared to Boeing's extensive outsourcing and other forms of program-based partnerships with global aerospace companies. Moreover, Airbus' investment in its commercial programs knowledge base has been much greater compared to Boeing, expressed in extensive patent applications and capital investments in the last two decades.

The main claim of this thesis is that an analysis that is strictly based on corporations' business and technology strategies is insufficient to give a clear picture of the orientations of their broader productive activities. For this reason, the thesis proposes the business/productive models analytical framework which focuses on not only the strategies related to technology development and supply chain organization but also the industrial organization of the companies investigated and the degree of their financial commitment to support innovation as a whole. The framework, different than the technology and business strategy literatures, includes organizational and financial components. As a result, the strategy component of these two companies' business/productive models were complemented with the research on their organizational and financial structures that is available in the fourth and fifth chapters of the thesis.

The fourth chapter on organization discussed the organizational dynamics of the work systems of the two companies and their implications over their corporate governance mechanisms. The organization element of the systems integration business/productive model is the component where conflicting relations between stakeholders are the most highlighted and institutional interventions are the most visible. It is also the component where the differences between the two companies in terms of their employee-employer relationships, industrial relations and the means and forms of conflict resolution are the most prevalent. Nevertheless, whether the forms of negotiation, employee representation and workers' participation in decision making widely differ, the two companies have shared aims to increase productivity, to maintain flexibility of work for production downturns and to relocate work due to internal restructuring efforts. To do so, they continuously try to modify work schemes and practices in line with work schedule, cost and market performance of their products. Concerns over job security and the employee benefits are shared issues for both companies' workforce. In both cases, the ability of labor to have an influence over the decisions on the organization of production is primarily conditioned by the degree of power of workers' representation and participation despite institutional differences.

The final chapter was on the comparison of the degree of financial commitment at Airbus and Boeing and the differences and similarities in their approaches to value creation and value extraction. The comparison was made in the light of the recent transformations in financial motives and objectives of business firms and in corporate finance which was discussed around the financialization concept introduced and developed mostly by heterodox scholars in the last two decades.

The comparison was made in two parts. First the sources of finance in developing a new aircraft were identified. Second, the uses of finance of two companies were compared and contrasted in terms of their shareholder value distribution practices and their uses of the functions of stock markets. Between the two firms, there is a slow but gradual conversion in terms of extensive shareholder value distribution through dividends and share repurchases, and increasing stock-based compensation for their CEOs and other top executives.

To repeat, general results of this research show that there is a strong correlation between extensive outsourcing, financialization of business strategies and conflicting employment relations. In analyzing these so-called systems integration strategies, one has to identify the role of the transformations of finance and work organization/industrial relations in the last three decades and their implications over specific business firms in order to explore distinct constructive and destructive processes of any corporate strategy.

Implications for Policy and Corporate Governance

While the developments of the previous period turned the commercial aircraft manufacturing into a global duopoly in civil aircraft segments and an oligopoly in defense aerospace, the future is set for another global overhaul of commercial aircraft manufacturing and aerospace. In that context, the future of Western aerospace is strongly linked to the future of general Western industrial and manufacturing success. The increasing role of the product markets such as the rise of Asian markets, colossal costs of product development, the massive knowledge base required and technological and organizational skills for ever complex products, make the long-term future of the industry in the US and Europe even more uncertain.

Detailed in the Appendix of this thesis, the worries over deindustrialization in the West recall the bygone debate on industrial policy. On both sides of the Atlantic the disinterest of policy makers and scholars since the early 1980s (Francis and Pevzner, 2006) largely disappeared with the heated debate over deindustrialization during the global financial crisis. The critics over the failure of national policies on industry or their nonexistence brought about open calls for a new generation of industrial or macroeconomic policies (Atkinson, 2012; Bertrand et al., 2012; Ezell and Atkinson, 2011; Gaffard, 2013; MIT, 2013).

The analysis in the second chapter on the role of government shows that government support has rendered aerospace industries of the West immune to the rapid fall in manufacturing in the last three decades. The multiplication of the forms of government support shows that policy inaction to support manufacturing is not valid in the case of aerospace and commercial aircraft manufacturing. Government support is one of the major reasons behind the success of the industry in terms of innovation and economic value added provided to the national economies. However, besides any form of financial support to be granted to national firms and regulatory changes, as a response to the aging aerospace workforce highlighted in the fourth chapter, strong attention must also be given to the training of a new generation of the workforce capable of developing and handling new technologies. The mounting concerns of industry experts, government representatives and the informed public for the future of aerospace in the US and Europe, and the lack of integrated consensus to guide industrial policies and programs, call for new business models to promote a healthy transition to the development and utilization of next-generation aerospace technologies. As an example, industry-specific policies at the national or regional levels must address the ongoing internationalization of the industry, which will further reduce the ratio of aircraft exports to imports for manufacturing countries. The ratio has already decreased from 95 percent in the 1960s to 55 percent in 2000s in the case of the US (Fingleton, 2005).

Moreover, other major challenges of aerospace including but not limited to growing commercial air travel, rising consumption of oil-based fuels, increased congestion of air traffic control systems, over-capacity of airports and the introduction of new air transport vehicles like drones will only be answered through further application of new technologies together with corresponding policy framework and business action. Mounting needs for ever safer, more reliable and more efficient aircraft have not so far forced OEMs to radically change their design, research and manufacturing platforms. However, Western OEMS are usually at the edge of the technological frontiers of their existing platforms, and the new models which will appear the earliest in late 2020s should incorporate not only radically different technologies but also a new industrial structure shaped by an ever stronger competition of multiple OEMs and a new supply chain structure. For new entrants, capabilities that help to manage the transition process from design to production (Mowery, 1988) as well as from production to a safety operation record to convince more airlines, especially foreign ones to buy new models they have never used are the most important elements of commercial success. Another question is to construct one's own supply chain which necessitates substantial organizational capabilities both inward and outward. The issue, different than before if independent entry would be feasible or not (Mowery, 1990), is to organize one's own authentic systems integration.

The sustainability of Western industrial and manufacturing success cannot solely depend on the extend of government policy and its effectiveness in supporting sustainable industrial growth. No innovation or industrial policy can be successful without concordant corporate practices focused on innovation and capability development. The widening gap between public policies to preserve productive capabilities of national economies and the corporate strategies can only be reduced with sound corporate actions which have to move away from practices shaped by the financialized and value extraction logic of the shareholder value era of the last three decades. These actions should help corporations to maintain high-end, high-productivity manufacturing that in turn sustains high-wage employment opportunities that can keep Western national economies prosperous. Corporations should have a long-term agenda to promote innovation, creation of new skills, career development or on-the-job training in order to protect the long-term interests of stakeholders against the short-term logic of value extraction. Cost-cutting has to be redefined in order to distinguish productivity increases through the efforts of workforce and other stakeholders from unmatched leverage of corporate managements to accomplish shareholder-value maximization goals. Finally, the risk-reward balance has to be reestablished in favor of the economic actors who make contributions of effort and money to the innovation process (Lazonick and Mazzucato, 2013).

The dead ends of excessive CEO pay, lack of corporate accountability, and misaligned interests of different stakeholders drag Western companies into vicious circles of the loss of competitiveness, faltering capability development and innovativeness in the long-run. Contrary to the mainstream statements which put stock markets together with stock buyers and sellers at the center of the economic value of governance efforts (OECD, 2014), a broader agenda reframes the purpose and obligations of corporations so that they also take into account interests of stakeholders other than just shareholders (Lazonick, 2015a; Palley, 2007). Only a combination of sustainable business practices and government policy can enable the conditions to sustain high-productivity with high-wage employment opportunities.

As Boorer et al. (1969) stated more than 40 years ago:

> "*Historically each succeeding step in aeronautical engineering or advance in the state of the art has taken longer from its conception to commercial application. The technical jumps have progressively become greater and from the early pioneering adventures the whole air transport industry has become a sophisticated business, dependent on cost effectiveness*".

However, the audacity of humankind throughout the 20th century beginning with the Wright Brothers' successful flight and the educating failures of many other aviation enthusiasts has now become restricted to corporate decision-making increasingly motivated by financial returns. Yet societies are in need of more efficient, cleaner and less costly air transport as they need more innovative drugs, safer and ethical food sources, and a better livelihood. Today's efforts to research and develop new technologies will determine the character of the livelihood in future decades which basically depends on the current level of investments in education, training and career development of younger generations.

Limitations of the research

The major limitation of this study originates from the dynamic character of the subjects analyzed, which are the industrial dynamics of commercial aircraft manufacturing and the relation of innovation dynamics to the strategic, organizational and financial orientations of business firms. The topics investigated in the last three chapters had to be updated regularly during the course of the thesis research and some findings would have been substantially different if the study had ended a couple of years ago or they might have been changed if it had been continued for several more years. As an example, when the patent data was first analyzed in early 2012, there was a large gap between Airbus and Boeing in terms of research in specific areas of aerospace and commercial aircraft manufacturing. But Boeing rapidly closed this gap in the last two years (2014 and 2015) with a reorientation of the company towards specific research in these areas. Similarly, the role of government support to commercial aircraft manufacturing continues to evolve in different directions, steadily nurturing the never-ending trade war between Airbus and Boeing. The extent and the implications of different support mechanisms are research topics that should be regularly re-identified and updated.

As expressed quite regularly throughout the thesis, even though the industry evolves slowly, it still contains a vivid dynamism marked with a constant change of interrelations among different stakeholders including governments that are involved in this productive activity.

The analysis on suppliers presented in the chapter on business strategies of Airbus and Boeing was not deepened from the perspective of the suppliers. While the collective and cumulative character of innovation was highlighted by the increasing workshares of major suppliers in latest programs of Airbus and Boeing and by the role of these two OEMs in contributing the capability development efforts of suppliers, the efforts of suppliers were not detailed. Suppliers' efforts to meet the stringent requirements of OEMs and their cost-cutting efforts expressed in continuously decreasing component prices have to be analyzed through a supplier-centered research framework which also highlights the competition among suppliers to win contracts from OEMs for their new aircraft development programs. These new contracts are the main instruments for suppliers to upgrade their technological and organizational capabilities. In addition, only through supplier-side research can OEM strategies to maintain a certain level of competition between suppliers in order to have access to latest technologies with favorable prices be revealed.

Another important limitation connected to the dynamism of the industry and firm-level research is the lack of updated qualitative data on industrial relations at the industry and company level. The impact of the systems-integration orientation on shop-floor dynamics with potentially varying differences in company sites and plants in different cities, regions or countries could not be explored from a labor-studies perspective. As a result, the study suffers from a lack of micro-level identification of organizational integration at shop floor, and hence cannot determine whether the systems integration business model has changed the set of relations that creates incentives for people to apply their skills and efforts to strategic objectives (Lazonick, 2013). The study only identified the broad contours of industrial relations at Airbus and Boeing highlighted by increasing concerns of job security and limited communication between the workforce and management with marked differences between the two firms. The lack of in-depth knowledge of shop-floor dynamics prevented the research from clearly defining the sources of similarities and differences between the two firms in terms of applying organizational integration to reach economic prosperity for the workforce and superior innovative performance of the company.

Future Research

This thesis focuses on commercial aircraft manufacturing as a specific industry, and a specific business/productive model embraced by the two major firms of the industry with noteworthy similarities and differences. Although it has a restricted focus, its integrated perspective with a focus on multiple aspects of productive organization and industrial dynamics contains a rich potential to be extended in different directions.

First of all, the research on aerospace and commercial aircraft manufacturing can be extended to the investigation of the development paths of supplier firms and the degree of their potential to upgrade. Similar to the business/productive models framework proposed in this study to inquire into the implications of the systems integration models of Airbus and Boeing and the tensions it has created between innovation and financialization; comparative analyses of suppliers can be done through a similar business-model framework. The models can be developed for supplier firms with a focus on specific groups like suppliers performing in similar business segments, suppliers in a specific region or suppliers having different customer groups like single or multiple number of OEMs (Airbus, Boeing, Bombardier, Embraer, COMAC) or other tier-1 suppliers serving OEMs. Besides a comparative analysis of their financial structures and their access to finance, including funds provided by governments, through a qualitative methodology the interrelated dynamics between the access to finance, the development of their skill bases and their upgrading potential and increased bargaining power vis-à-vis tier-1 suppliers or OEMs can be compared and contrasted. Their growth prospects can be revealed by looking at their capability development efforts, empowered by continuous access to finance and gradual development of their skill bases. The role of government support can also be further investigated in detail with a company focus. Such a research agenda can also address another limitation of this study: the diversity of suppliers in terms of their industrial activity. Some of these suppliers are subject to technological and organizational dynamics of other industries (other than aerospace) and their innovative capabilities may largely be affected by different industry-specific dynamics.

In aerospace and commercial aircraft industry, another study can be focused on the rising competition mentioned in the chapter on industrial dynamics. It has become more evident that the capabilities of Western aerospace are going to be challenged due to an industry reorganization structured by the dynamics of increasing technological change, globalization of production, the emergence of new centers of aerospace, and corresponding evolution of corporate governance. Thus a comparative-historical analysis similar to that performed in this thesis can be extended to a global comparison of rival aircraft manufacturing companies in smaller commercial aircraft segments, namely Airbus (Europe), Boeing (USA), Bombardier (Canada), Embraer (Brazil), COMAC (China) and UAC (Russia). Again with a comparative business model methodology, the dynamics of world commercial aircraft manufacturing can be investigated. The research should also incorporate an institutional comparison which elaborates the differences of national innovation systems, financial commitment of national industrial actors and the impact of international collaborations on the innovative capabilities of OEMs. Such a research agenda could also include an international comparison of twenty-first century government support in aerospace and aerospace industrial policy which are gradually unfolding in different directions. Moreover, the research can also be extended to the comparison of the space programs of these countries and regions reflecting the rising competition in the development and deployment of launch vehicles, spacecraft and other spaceflight vehicles including space probes. Related developments in regulatory frameworks can also be investigated.

Last but not least, the continuing research on multiple dynamics of aerospace and commercial aircraft manufacturing industries can also be part of a broader research agenda on the evolution of firms and industries in the twenty-first century within the context of specific institutional conditions. The business/productive model methodology which integrates theory and history, with a focus on industry-specific attributes such as systems integration elaborated in this thesis, can be extended to the analysis of other industries to enable intra-industry comparisons and the diversifying impact of trans-industry phenomena like financialization on distinct geographies.

Appendix

The Fall of Manufacturing in the West

This appendix was prepared to extend the initial discussion introduced at the beginning of this study around the dynamics of long-term success in commercial aircraft manufacturing in the US and Europe towards a general overview of the state of manufacturing in Western economies.

It is widely accepted fact that manufacturing industries are key drivers of innovation. They account a great majority of company R&D spending in developed economies (EC, 2012; Tassey, 2010). A big part of product and process innovations are also realized within manufacturing (Boroush, 2010) and the manufacturing industries are especially engaged in in-house R&D in the case of process innovations (Eurostat, 2013).

In addition, manufacturing firms employ a much bigger ratio of engineers and other professional and technical employees compared with many other sectors of the economy and they are the leading source of employment with better-paid jobs for both highly educated and non-college-educated workers (Eurostat, 2013; Ezell and Atkinson, 2011; Levinson, 2012). Manufacturing is also a key enabler of national economic strength. With very high employment multipliers, it provides the conditions to have a vibrant national economy with a globally competitive traded sector. It is still the largest traded sector of the United States economy (Atkinson et al., 2012) and 75 percent of EU export comes from manufacturing (EC, 2012).

Descriptive statistics show the slowdown of manufacturing for almost every advanced economy of the West. However, the stark differences among these economies in detailed aspects of manufacturing capacity and the swift expansion of Chinese manufacturing capacity in relation to other major economies entail further discussion over the significance of manufacturing for any dynamic economy in the pursuit of sustainable growth.

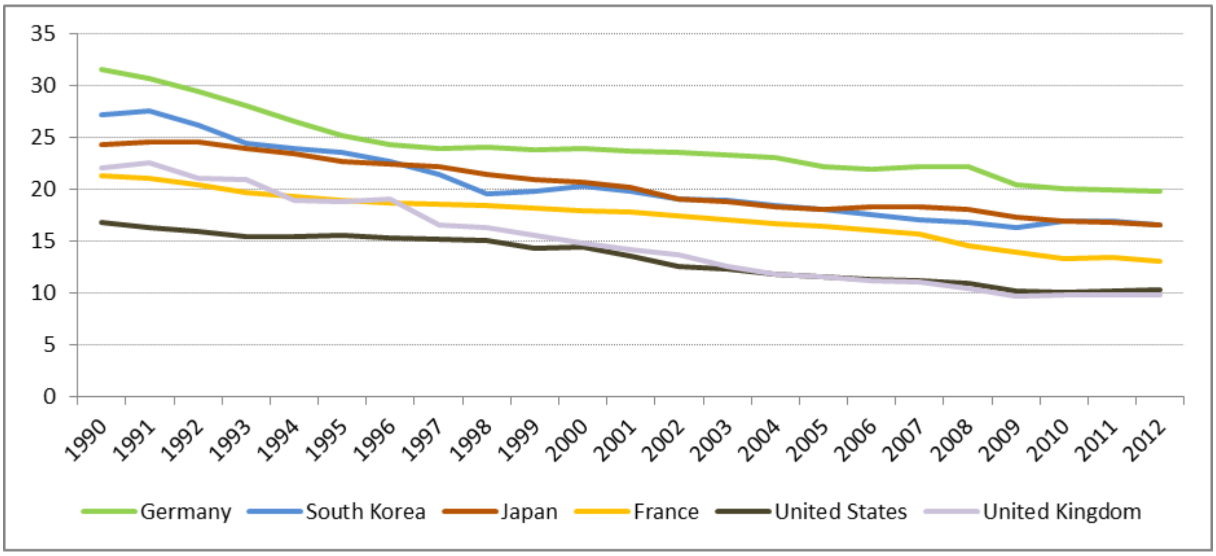
The rapid decline of manufacturing in the US and in several other developed economies in the last decade escalated the concerns about the future of manufacturing in the industrialized world. In the case of the US, reasons proposed by scholars beyond the mainstream explanations of deindustrialization around impact of productivity growth and international competition (Lawrence and Edwards, 2013; OECD, 2007; Rowthorn and Ramaswamy, 1998; Rowthorn and Wells, 1987;) include extensive outsourcing (Pisano and Shih, 2009), rising international trade (Boulhol and Fontagné, 2006), increased Chinese exports (Autor et al., 2013), establishment of permanent normal trade relations with China which eliminated uncertainties over potential trade restrictions and contributed to the rapid rise of exports of this country (Pierce and Schott, 2012) and the failure of investment and industrial policy (Atkinson et al., 2012) or the gradual elimination of it (Wade, 2012). In Europe, in addition to concerns similar to the US, several other structural but market-specific reasons are also addressed including inefficiencies due to the underdevelopment of an intra-European market or difficulties to access to energy and a better business environment in general (EC, 2014). In the face of such inefficiencies and other problems with coordination, barriers to growth further increase the potential differences in national and regional economic performance across Europe (Gaffard, 2013).

As the economic activity is primarily about resource allocation and the decisions taken over the resource allocation impose immediate consequences on working age population, the major concern is the ability of the economic sectors to provide opportunities for the workforce to upgrade or maintain their welfare standards with their existing jobs. However, many of the international statistics used for comparative purposes are unable to show the worsening trends for Western manufacturing in terms of welfare, skills or career opportunities for manufacturing labor and the contribution of the sector to the general welfare of the nation. A description of the degrading productive base of the West has to rely on the macro-level data, mostly incapable of giving details where the devil is generally hidden.

Even though the available statistics to measure the qualitative and quantitative aspects of deindustrialization are not very suitable for international comparisons, this section presents existing descriptive numbers in order to show the divergent and convergent trends among different economies around specific indicators of manufacturing strength. When taken together, they may provide some evidence that manufacturing bases of some Western economies has notably weakened over the last decades.

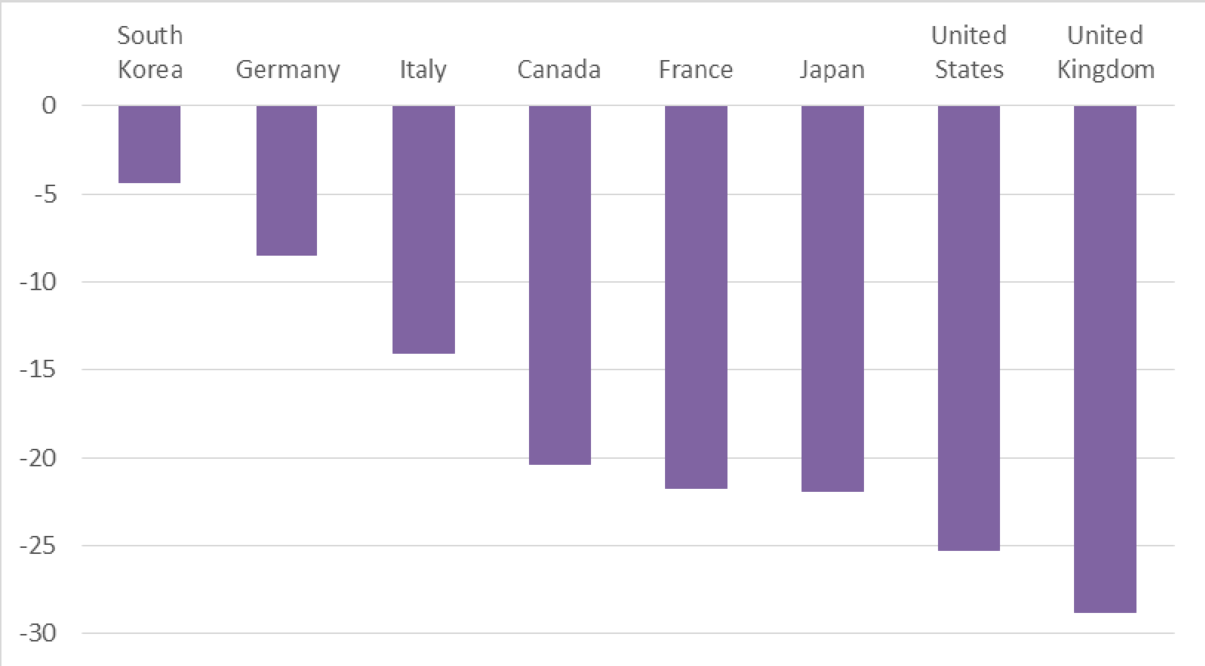
The most widely used statistics to show the decreasing role of manufacturing is the fall in manufacturing employment across the developed world. From 1990 to 2012, the number of manufacturing jobs fell both absolutely and as a percentage of total employment almost every country in the West as Figure A.1a shows. As an example, during this period (1990-2012), manufacturing jobs fell by 5.2 million in the US. In the seven biggest economies of the European Union (Germany, France, UK, Italy, Spain, Netherlands and Sweden) for the same period the same figure is 7.5 million lost jobs. The UK is the biggest loser with 3 million manufacturing jobs disappeared during the period. Figure A.1b shows the percentage losses in the period between 2000 and 2012. Countries in general meet with substantial losses in their manufacturing jobs during recessionary periods, without remarkable gains during recovery. For many countries, however, most of the loss was especially in the last decade despite a boom period after economic recession of early 2000s.

Figure A.1a: Manufacturing employment as a percentage of total employment in selected countries, 1990-2012



Source: The U.S. Bureau of Labor Statistics

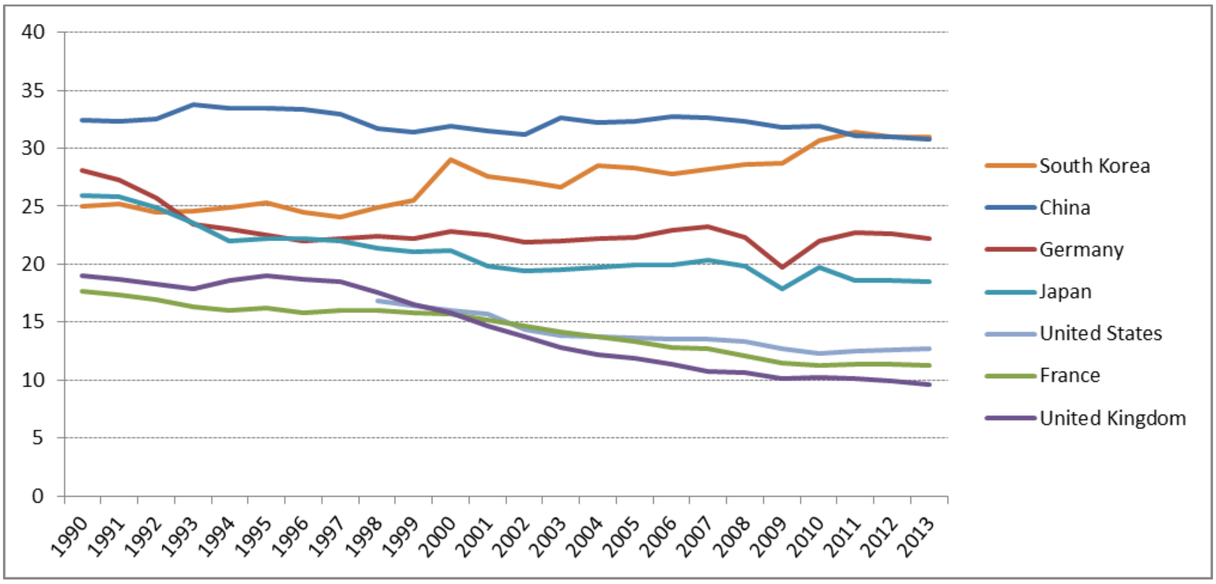
Figure A.1b: Percent Change in Manufacturing Jobs in Selected Countries, 2000-2012



Source: The U.S. Bureau of Labor Statistics

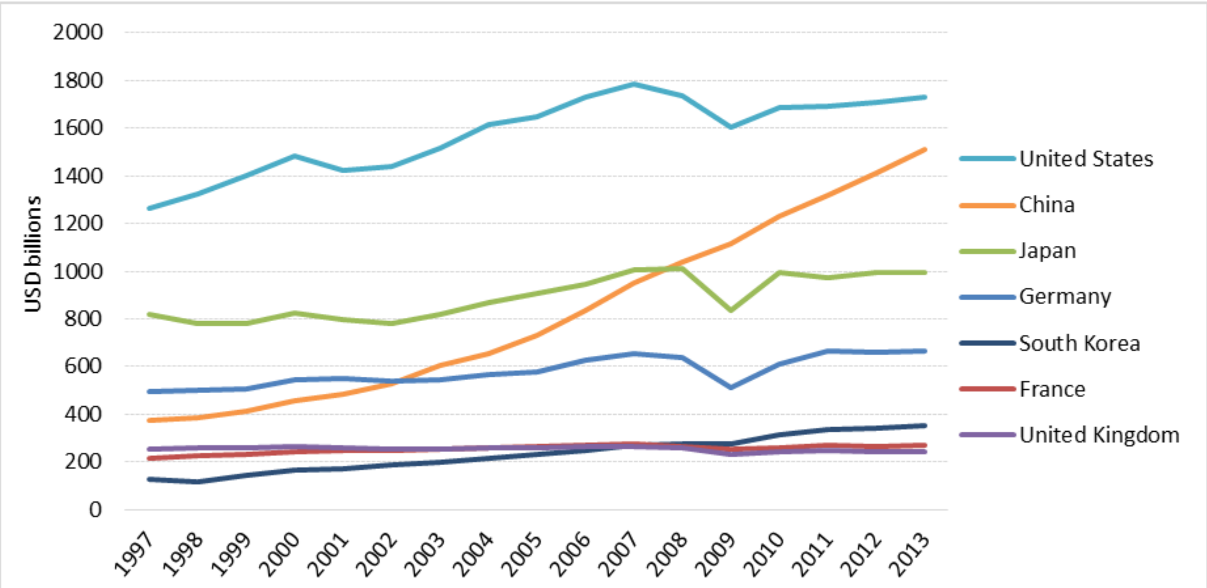
As long as comparative international statistics are available, providing as much evidence as possible on the economic performance of manufacturing and industry is essential to show divergences and/or convergences between economies. While the share of manufacturing employment decreased in every developed economy in the last two decades, manufacturing output presents another picture. Real manufacturing value added has declined as a share of GDP in some developed economies including France, the United Kingdom and the United States, after a period of retraction in the early 1990s, while it is stable or even growing in others including, Germany, Japan and South Korea. China's share of manufacturing has also been stable at over 30 percent during the entire period (Figure A.2a). Such a higher ratio compared to other major world economies is reflected in the steep increase of total value added of China (Figure A.2b). Its output surpassed Germany in 2002, Japan in 2008 and has been approaching to the US output with an average annual growth of approximately 10 percent in the period between 2004 and 2013. The divergence occurred between advanced economies in the last decade is the result of the varying growth rates of manufacturing value added output. Manufacturing real value added in some Asian economies including Japan and most Northern European economies increased considerably while it fell between two to 15 percent in other major economies of the West including the US, the UK, France, Spain, Italy and Canada (Figure A.2c). As an example, the US trade deficit in manufactured products totaled nearly $4.5 trillion from 2000 to 2010 (Atkinson et al., 2012).

Figure A.2a: Manufacturing value added as a percentage of country GDP, 1990-2013



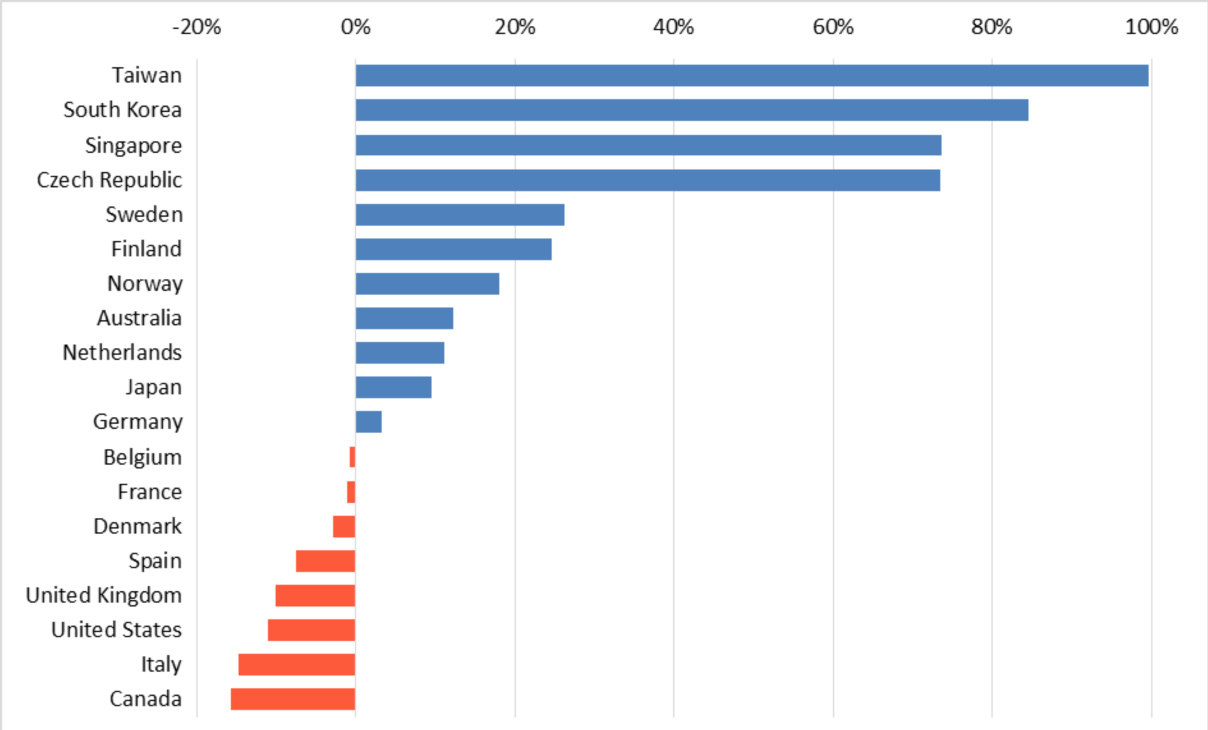
Source: The World Bank World Development Indicators

Figure A.2b: Manufacturing value added, constant 2005 US$, 1997-2013



Source: The World Bank World Development Indicators

Figure A.2c: Percentage change in manufacturing real value added (US adjusted), 2000-2010



Source: Atkinson et al., 2012

The divergence between countries is also reflected at the industry level. Some of the decline or increase in value added is common to every major economy in specific industries like textiles or pharmaceuticals respectively, due to industry specific factors that can be explained through demand trends, technological change or competitive pressures of the emergent economies. However, many of the industries still reflect the divergent dynamics in manufacturing value added among developed economies. Excluding computer, electronics and pharmaceutical industries which are uniformly positive in terms of increasing value added during the 11 years between 2000 and 2010 in all countries, only South Korea and Germany have grown more than half of their industries in the list. The US has only one single industry with value added increase during the period and the performance of France and Italy has also been less than mediocre. These countries lost an important part of their industrial competitiveness in the last two decades.

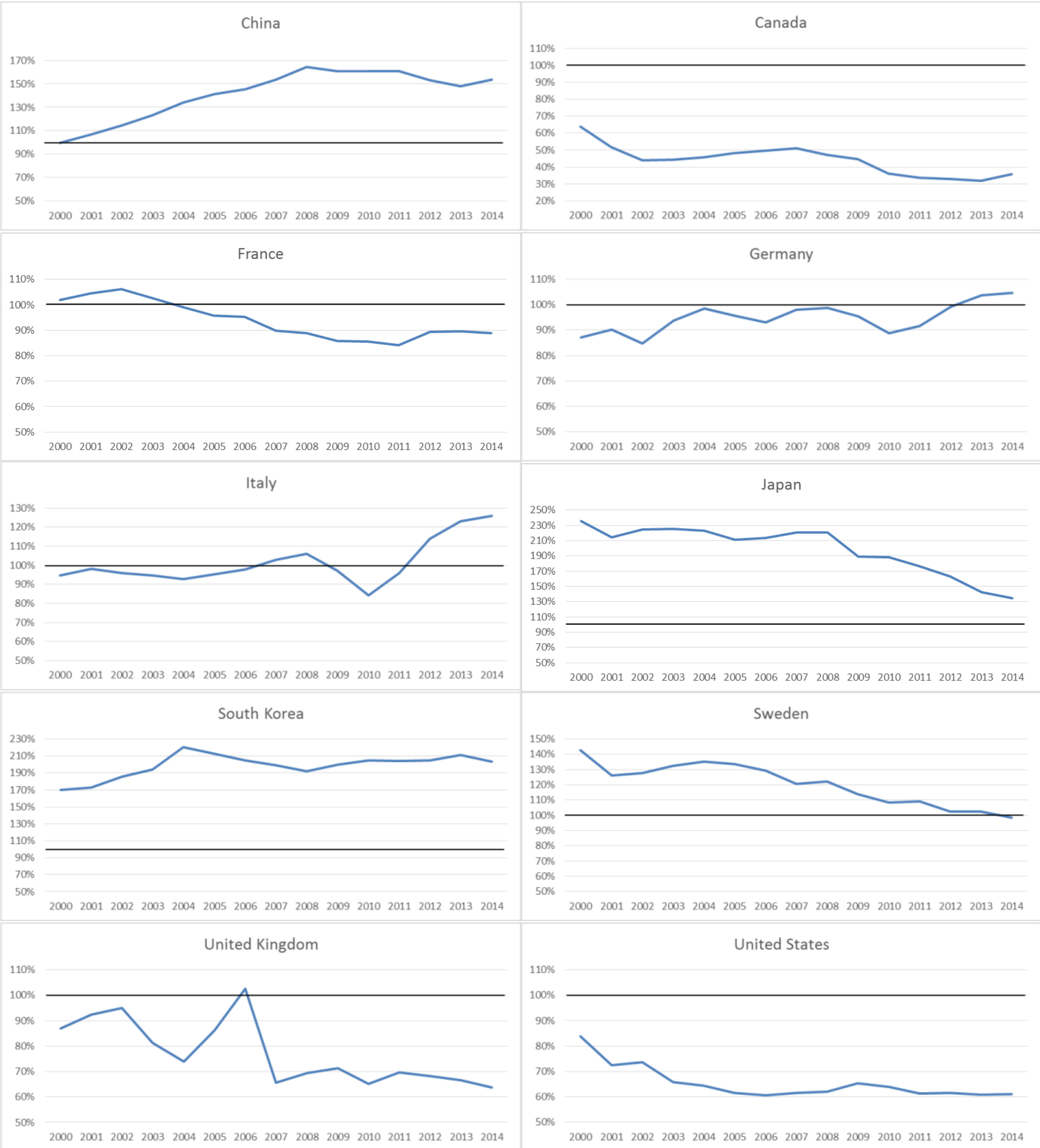
Table A.1: Value added change in 12 manufacturing industries in specific countries between 2000 and 2010 (in volume)

	USA	Germany	France	S. Korea	Italy	Sweden
D13 Textiles	-	-	-	-	-	-
D17 Paper & paper products	-	+	-	+	+	+
D20 Chemicals & chemical products	-	+	-	+	-	+
D21 Basic pharmaceutical products & pharmaceutical preparations	+	+	+	+	+	+
D22 Rubber & plastics products	-	+	+	+	-	+
D24 Basic metals	-	-	-	+	-	-
D25 Fabricated metal products, except machinery and equipment	-	+	-	+	+	-
D26 Computer, electronic & optical products	+	+	+	+	+	+
D27 Electrical equipment	-	-	-	+	+	-
D28 Machinery & equipment n.e.c.	+	-	+	+	+	+
D29 Motor vehicles, trailers & semi-trailers	-	+	-	+	-	+
D30 Other transport equipment	-	+	+	+	-	-
Number of industries with value added growth (out of 11)	**3**	**8**	**5**	**11**	**6**	**7**
less computers & pharmaceuticals (out of 9)	**1**	**6**	**3**	**9**	**4**	**5**

Source: OECD STAN Database for Structural Analysis (ISIC Rev. 4)

Declining competitiveness resulted in negative value added growth also explains the distorting trade balances in manufacturing goods especially of industries utilizing advanced degree of knowledge and technologies. While the countries in the list above have uniformly increased their volume of value added during the last decade in pharmaceuticals and computer and electronics, their trade balances show the divergences in their strength of competitiveness within these industries. Despite their value added growth, countries like France, United States and Sweden, together with United Kingdom, Japan and Canada which are not in the previous list display a decline in balances in similar industries. The balances of Germany, Italy, South Korea, Spain and China have increased since 2000 with a positive coverage ratio as of 2014 (Figure A.3).

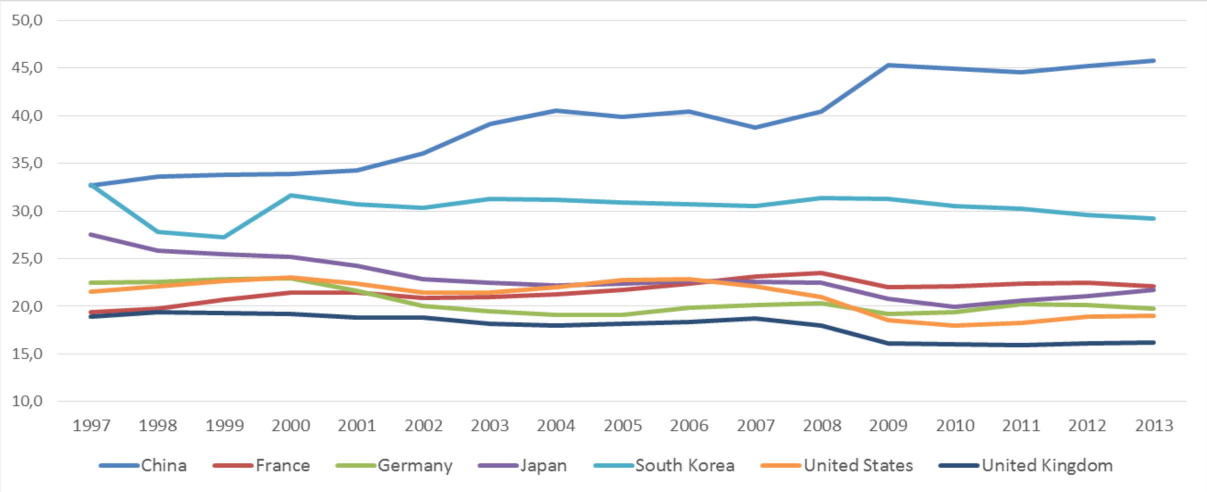
Figure A.3: Merchandise Trade Balance of a selected group of economies in a group of advanced technology products, by commodity



The group includes pharmaceuticals, electronic data processing and office equipment, telecommunications equipment and integrated circuits and electronic components, the black line crossing 100 percent indicates the full trade balance
Source: WTO Time Series on international trade.

Finally, the decline is also expressed in the decreasing share of fixed capital formation in many of these economies (Figure A.4) which is one of the main basis for a healthy manufacturing sector within an economy as it includes a wide range of activities including but not limited to physical infrastructure development like land improvements, construction of roads, railways, or buildings including commercial and non-commercial ones, and plant, machinery and equipment purchases (WBDI).

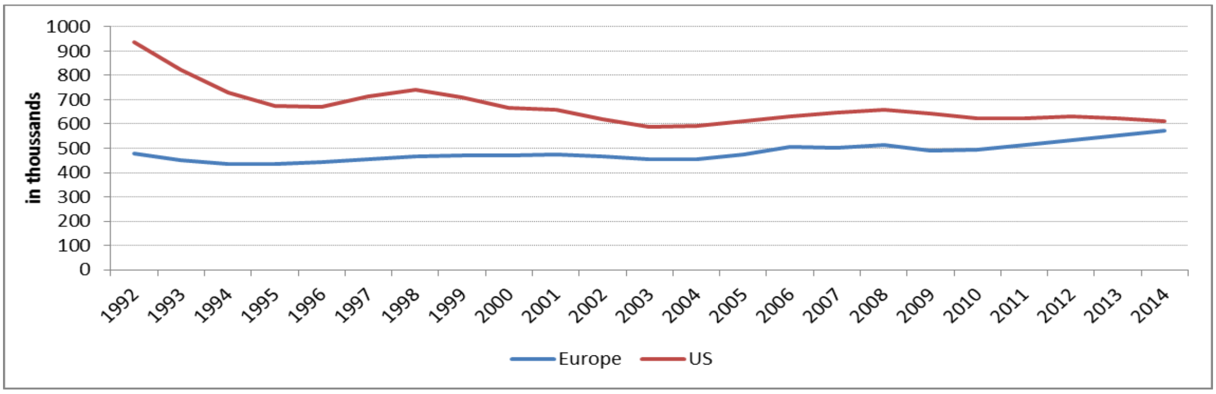
Figure A.4: Gross fixed capital formation (Percentage of GDP)



Source: The World Bank World Development Indicators

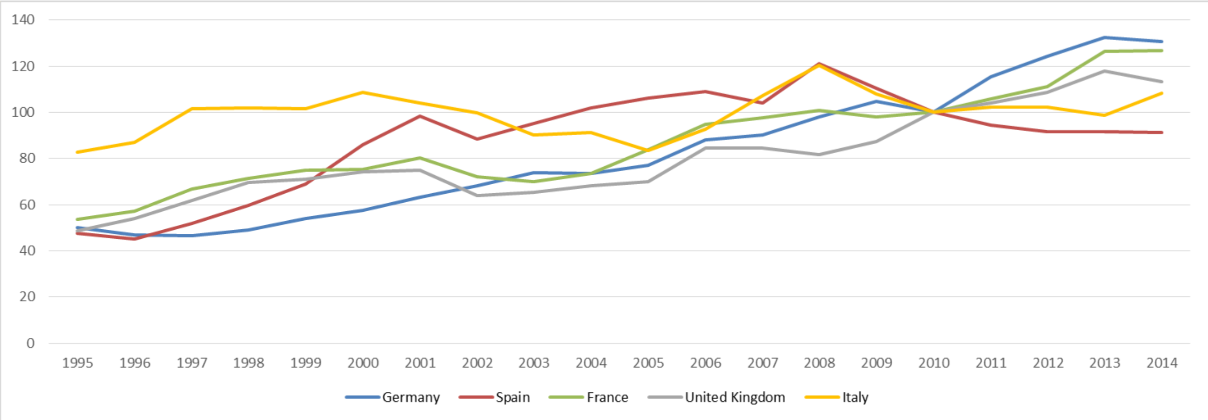
In the aerospace industry, a major manufacturing end export industry both in the US and in Europe, the level of employment has stabilized in 2000s after a steep fall in employment in the early 1990s mostly due to the rapid decrease in defense budgets all over the world at the end of Cold War (Figure A.5). More interestingly, even though it is much stronger in Europe, aerospace manufacturing output in terms of production volume has also notably increased in the last two decades (Figure A.6a & A.6b). In Germany and France, two main Airbus countries, the increase is more than twofold since 1995. Diverging destiny of the aerospace industry from the rest of the manufacturing sector is a primary incentive of this study to analyze the extent of the role of different factors supporting the industry.

Figure A.5: Aerospace employment in the US and Europe, 1992-2012



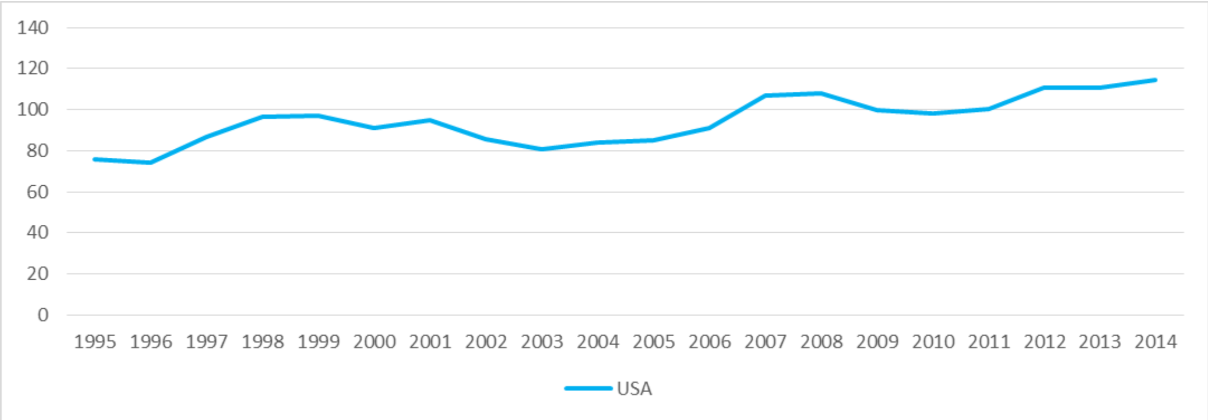
Source: Aerospace Industries Association for the US, Aerospace & Defence Industries Association for Europe

Figure A.6a: Aerospace Manufacturing Output in Airbus' Home Countries and Italy (2010=100)



Source: Eurostat

Figure A.6b: Value of US Aerospace Manufacturing Shipments (2009 = 100)



Source: Aerospace Industries Association

Bibliography

Acha V., Brusoni S., Prencipe A. [2007] "Exploring the miracle: strategy and management knowledge of the knowledge base in the aeronautics industry", *International Journal of Innovation and Technology Management*, vol. 4, n°1, pp. 15-39.

Acha V., Brusoni, S. [2008] "The changing governance of knowledge in avionics", *Economics of Innovation and New Technology*, vol. 17, n°1-2, pp. 43-57.

AIA [2008] "Launching the 21st Century American Aerospace Workforce", *Aerospace Industries Association*, December.

AIA [2011] "Human Capital Management", *Aerospace Industries Association*, December.

Alexander M., Young D. [1996] "Outsourcing: Where's the value?", *Long Range Planning*, vol. 29 n°5, pp. 728-730.

Amable B. [2002] "La Théorie de la Régulation et le Changement Technique" in Boyer R. et al., *Théorie de la régulation, l'état des savoirs*, Paris: La Découverte, pp. 236-244.

Amable B. [2003] *The Diversity of Modern Capitalism*, Oxford: Oxford University Press.

Amable B., Barre R., Boyer R. [1997] *Les systèmes d'innovation à l'ère de la globalisation*, Paris : Économica.

Amesse F., Dragoste L., Nollet J., Ponce S. [2001] "Issues on partnering: evidences from subcontracting in aeronautics", *Technovation*, vol. 21, n°9, pp. 559-569.

Aoki M. [2001] *Toward a Comparative Institutional Analysis*, Cambridge: The MIT Press.

Arnold and Porter [1991] *U.S. Government Support of the U.S. Commercial Aircraft Industry*, Prepared for the Commission of the European Communities, Washington D.C., November.

Arrow K. J. [1962] "The Economic Implications of Learning by Doing", The Review of Economic Studies, vol. 29, n°3, pp. 155-173.

Atkinson R. D., Stewart L. E., Andes S. M., Ezell S. J. [2012] "Worse Than the Great Depression: What Experts Are Missing About American Manufacturing Decline", *The Information Technology & Innovation Foundation*, Washington D.C., March.

Autor D. H., Dorn D., Hanson G. H. [2013] "The China Syndrome: Local Labor Market Effects of Import Competition in the United States", *American Economic Review*, vol. 103 n°6, pp. 2121-2168.

Baldwin R., Krugman P. [1988] "Industrial Policy and International Competition in Wide-Bodied Jet Aircraft", in Baldwin R. ed., *Trade Policy Issues and Empirical Analysis*, Chicago: University of Chicago Press, pp. 45-78.

Barthélemy J. [2003] "The seven deadly sins of outsourcing", *Academy of Management Executive*, vol. 17 n°2, pp. 87-98.

Batt R.L., Appelbaum E. [2013] “The Impact of Financialization on Management and Employment Outcomes”, *Upjohn Institute Working Papers*, n°13-191.

Bauernschuster, S., Falck O., Heblich S. [2009] “Training and innovation”, *Journal of Human Capital*, vol. 3 n°4, pp. 323-353.

Beauclair N. [2007] “New deal for Airbus suppliers”, *Interavia*, December 31.

Beaugency A., Sakinç M. E., Talbot D. [2015] “Outsourcing of strategic resources and capabilities: opposing choices in the commercial aircraft manufacturing”, *Journal of Knowledge Management*, vol. 19, n°5, pp. 912-931.

Bélis-Bergouignan M. C., Jullien B., Lung Y., Yildizoglu M. [2010] *Industries, Innovation, Institutions. Eléments de dynamique industrielle*, Pessac: Presses Universitaires de Bordeaux.

Benkard C. L. [2000] “Learning and Forgetting: The Dynamics of Aircraft Production”, *American Economic Review*, vol. 90 n°4, pp. 1034-1054.

Best M. H. [2003] “The Geography of Systems Integration” in Prencipe A., Davies A., Hobday M. eds., *The Business of Systems Integration*, Oxford: Oxford University Press, pp. 201-228.

Bhargava A. [2013] “Executive compensation, share repurchases and investment expenditures: econometric evidence from US firms”, *Review of Quantitative Finance and Accounting*, vol. 40, n°3, pp. 403-422.

BLS [2006] “Career Guide to Industries, 2006-07” *Bureau of Labor Statistics U.S. Department of Labor*.

Boeing [2009] *Background Information: Airbus Subsidies*, Chicago.

Boroush M. [2010] “NSF Releases New Statistics on Business Innovation”, *National Science Foundation Directorate for Social, Behavioral, and Economic Sciences*, NSF 11-300.

Boulhol H., Fontagné L. [2005] “Deindustrialisation and the fear of relocations in the industry”, *Centre D’Etudes Prospectives et D’Informations Internationales Working Papers*, n°2006-07, March.

Boyer R. [2000] “Is a Finance-led growth regime a viable alternative to Fordism? A preliminary analysis”, *Economy & Society*, vol. 29 n°1, pp. 111-145.

Boyer R. [2004] *Théorie de la régulation : Les fondamentaux*, Paris: La Découverte.

Boyer R. [2005] “From Shareholder Value to CEO Power: the Paradox of the 1990s”, *Competition & Change*, vol. 9, n°1, pp. 7-47.

Boyer R., Freyssenet, M. [1995] “Emergence De Nouveaux Modèles Industriels: Problématique et démarche d'analyse” *Actes du GERPISA*, n°15.

Boyer R., Freyssenet, M. [2000a] *Les modèles productifs*, Paris: La Découverte.

Boyer R., Freyssenet, M. [2000b] The World That Changed the Machine: An analysis schema of productive models, *La Lettre du GERPISA,* February-June.

Boyer R., Freyssenet, M. [2002] “Globalization but Still a Large Diversity of Productive Models and Corporate Governance Styles”, *Seoul Journal of Economics*, vol. 15, n°2, pp. 149-191.

Braddon D. [1999] “Commercial applications of Military R&D: US and EU Programs compared”, *European Union Studies Association (EUSA) 6th Biennial Conference*, June 2-5.

Brinkmann U., Nachtwey O. [2013] “Industrial Relations, Trade Unions and Social Conflict in German Capitalism”, *La nouvelle revue du travail*, vol. 3/2013, URL: http://nrt.revues.org/1382.

Bryce D. J., Useem M. [1998] “The Impact of Corporate Outsourcing on Company Value”, *European Management Journal*, vol. 16, n°6, pp. 635-643.

Brusoni S., Prencipe A., Pavitt K. [2001] “Knowledge specialization and the boundaries of the firm: why do firms know more than they make?”, *Administrative Science Quarterly*, vol. 46, n°4, pp. 597–621.

Brusoni S., Prencipe A. [2001] “Unpacking the Black Box of Modularity: Technologies, Products and Organisations”, *Industrial and Corporate Change*, vol. 10, n°1, pp. 179-205.

Burchell B. [2001] “The prevalence and redistribution of job insecurity and work intensification”, in Burchell B., Ladipo D., Wilkinson F. eds., *Job Insecurity and Work Intensification*, London: Routledge, pp. 61-76.

Burchell B., Ladipo D., Wilkinson F. [2001] *Job Insecurity and Work Intensification*, London: Routledge.

Burreson M. [2013] “Boeing Workforce Development and Training”, *Boeing Commercial Airplanes*, July.

Carbaugh R., Olienyk J. [2001] “Boeing-Airbus Subsidy Dispute: An Economic and Trade Perspective”, *Global Economy Quarterly*, vol. 2, n°4, pp. 261-282.

Carbaugh R., Olienyk J. [2004] “Boeing-Airbus Subsidy Dispute: A Sequel”, *Global Economy Journal*, vol. 4, n°2.

Castello P. [2010] “New insights on EU-US comparison of corporate R&D”, *IPTS Working Paper on Corporate R&D and Innovation*, n°01/2010, March.

Chandler A. [1962] *Strategy and Structure: Chapters in the History of the American Industrial Enterprise*, Cambridge: MIT Press.

Chandler A. [1977] *The Visible Hand: The Managerial Revolution in American Business*, Cambridge: Belknap Press of Harvard University Press.

Chandler A. [1990] *Scale and Scope: The Dynamics of Industrial Capitalism*, Cambridge: Belknap Press of Harvard University Press.

Chandler A. [1992] “Organizational Capabilities and the Economic History of the Industrial Enterprise”, *The Journal of Economic Perspectives*, vol. 6, n°3, pp. 79-100.

Chandler A.J. [1993] “Organizational Capabilities and Industrial Restructuring: A Historical Analysis”, *Journal of Comparative Economics*, vol. 17, pp. 309-337.

Chapman H. [1991] *State Capitalism and Working-Class Radicalism in the French Aircraft Industry*, Berkeley: University of California Press.

Chesbrough H. W. [2006] “Open Innovation: A New Paradigm for Understanding Industrial Innovation” in Chesbrough H. W., Vanhaverbeke W., West J. *Open Innovation: Researching a New Paradigm*, Oxford: Oxford University Press, pp.1-15.

Chesbrough H. W. [2007] “Business model innovation: it’s not just about technology anymore”, *Strategy & Leadership*, vol. 35, n°6, pp. 12-17.

Chesbrough H. W. [2010] “Business Model Innovation: Opportunities and Barriers”, *Long Range Planning*, vol. 43, pp. 354-363.

Chesbrough H. W., Teece D. [1996] “Organizing for Innovation: When is Virtual Virtuous?”, *Harvard Business Review*, vol.74, n°1, pp.65–73.

Chesbrough H. W., Rosenbloom R. S. [2002] “The role of the business model in capturing value from innovation: Evidence from Xerox Corporation’s technology spinoff companies”, *Industrial and Corporate Change*, vol.11, n°3, pp.529-555.

Christensen C. M. [1997] *The innovator's dilemma: when new technologies cause great firms to fail*, Boston: Harvard Business School Press.

Christensen C. M., Rosenbloom R. S. [1997] “Explaining the attacker's advantage: technological paradigms, organizational dynamics, and the value network”, *Research Policy*, vol. 24, n°2, pp. 233-257.

Christensen C. M., Stephen K., Willy S. [2008] “Innovation Killers: How Financial Tools Destroy Your Capacity to Do New Things?”, *Harvard Business Review*, January, pp. 98-105.

Collis D. J. [1994] “Research Note: How Valuable Are Organizational Capabilities?”, *Strategic Management Journal*, vol. 15, n°S1, pp. 143-152.

Condit P. M. [1994] “Focusing on the customer: How Boeing does it”, *Research-Technology Management*, vol. 37, n°1.

Crescenzi R., Rodriguez-Pose A., Storper M. [2007] “The territorial dynamics of innovation: A Europe–United States comparative analysis”, *Journal of Economic Geography*, vol. 7, n°6, pp. 673-709.

Crotty J. [2003] “The Neoliberal Paradox: The Impact of Destructive Product Market Competition and Impatient Finance on Nonfinancial Corporations in the Neoliberal Era”, *Review of Radical Political Economics*, vol. 35, n°3, pp. 271-279.

Danford A., Richardson M., Stewart P., Tailby S., Upchurch M. [2004] “High performance work systems and workplace partnership: a case study of aerospace workers”, *New Technology, Work and Employment*, vol. 19, n°1, pp. 14-29.

d'Apollonia A. S. [2010] "A350 XWB and the Extended Enterprise", *Conferences Aeromart Toulouse*, December.

Davies A. [2003] "Integrated Solutions: The Changing Business of Systems Integration" in Prencipe A., Davies A., Hobday M. eds., *The Business of Systems Integration*, Oxford: Oxford University Press, pp. 333-368.

Deloitte [2013] "Aerospace & Defense Cross-Border Joint Ventures Managing high complexity, driving remarkable growth", *Deloitte Financial Advisory Services LLP*.

Deloitte [2014] "2014 Global Aerospace and Defense Industry outlook", *Deloitte Global Services Limited*.

Department of Defense [1997] "Dual Use Applications Program Plans Announced", *U.S. Department of Defense Press Operations*, Release No: 015-97, January 14, available at http://archive.defense.gov/Releases/Release.aspx?ReleaseID=1126.

Dibiaggio L., Nasiriyar M. [2009] "Knowledge integration and vertical specialisation in the semiconductor industry". *European Management Review*, vol. 6, n°4, pp. 265-276.

Dobbin F., Zorn D. [2005] "Corporate Malfeasance and The Myth of Shareholder Value", *Political Power and Social Theory*, vol. 17, pp. 179-198.

Doerfler I., Baumann O., Becker M. [2012] "Choosing Paths to Becoming a Systems Integrator: Lessons from Airbus' "New Systems Policy"", Paper presented at *DRUID Conference*, Copenhagen, June 19-21.

Dore R. [2008] "Financialization of the global economy", *Industrial and Corporate Change*, vol. 17, n°6, pp. 1097-1112.

Dosi G., Hobday M., Marengo L., Prencipe A. [2003] "The Economics of Systems Integration: Towards an Evolutionary Interpretation" in Prencipe A., Davies A., Hobday M. eds., *The Business of Systems Integration*, Oxford: Oxford University Press, pp. 95-113.

Dostie B. [2014] "Innovation, Productivity, and Training", *Institute for the Study of Labor*, Discussion Paper n°8506, Bonn, September.

Dupuy C., Lung Y. [2002] "Institutional Investors and the Car Industry Geographic Focalisation and Industrial Strategies", *Competition & Change*, vol. 6, n°1, pp. 43-60.

Dussauge P., Garrette B. [1995] "Determinants of Success in International Strategic Alliances: Evidence from the Global Aerospace Industry", *Journal of International Business Studies*, vol. 26, n°3, pp. 505-530.

du Tertre C. [2013] "Travail, 'rapport salarial' et théorie de la régulation : apports et limites", *Travailler*, n°29, pp. 17-28.

EADS [2010] "Don't Let Boeing Close the Door on Competition", *Airbus Americas Research*, Herndon, May 26.

EC [2003] “Commission Regulation implementing Directive 2003/6/EC of the European Parliament and of the Council as regards exemptions for buy-back programmes and stabilisation of financial instruments”, *European Commission*, No 2273/2003, Brussels, December 22.

EC [2010] “The WTO Boeing-Airbus dispute”, *European Commission*, Brussels, March 22.

EC [2012] “A stronger European Industry for Growth and Economic Recovery”, *European Commission,* Press Conference, Brussels, October 10.

EC [2014] “Commission calls for immediate action for a European Industrial Renaissance”, *European Commission*, Brussels, March 8.

EC [2016] “Commission Delegated Regulation (EU) supplementing Regulation (EU) No 596/2014 of the European Parliament and of the Council with regard to regulatory technical standards for the conditions applicable to buy-back programmes and stabilisation measures”, *European Commission*, Press Release, Brussels, January 22.

Ecorys [2009] “FWC Sector Competitiveness Studies Competitiveness of the EU Aerospace Industry with focus on: Aeronautics Industry”, Framework Contract of Sectoral Competitiveness Studies – ENTR/06/054, *Ecorys Research and Consulting*, Munich, December 19.

EMR [2009] “EMR Special Issue on Strategic Dynamics in Industry Architectures: The challenges of Knowledge Integration”, *European Management Review*, vol. 6, n°4, pp. 209-277.

Erturk I, Froud J., Johal S., Leaver A., Williams K. [2007] “Against agency: a positional critique”, *Economy & Society*, vol. 36, n°1, pp. 51-77.

Erturk I., Solari S. [2007] “Banks as Continuous Reinvention”, *New Political Economy*, vol. 12, n°3, pp. 369-388.

Esposito E. [2004] “Strategic alliances and internationalisation in the aircraft manufacturing industry”, *Technological Forecasting & Social Change*, vol. 71, n°5, pp. 443-468.

Esposito E., Passaro R. [2009] “The evolution of supply chain relations hips: An interpretative framework based on the Italian inter-industry experience”, *Journal of Purchasing & Supply Management*, vol. 15, pp. 114–126.

Eurostat [2013] *Science, technology and innovation in Europe 2013 edition*, Luxembourg: Publications Office of the European Union.

Ezell S. J., Atkinson R. D. [2011] “The Case for a National Manufacturing Strategy”, *The Information Technology & Innovation Foundation*, Washington D.C., April.

FAA [2014] *Boeing 787–8 Design, Certification and Manufacturing Systems Review*, Prepared for Federal Aviation Administration and Boeing Commercial Airplanes, March 19.

Fagerberg J., Mowery D., Nelson R. [2005] *The Oxford Handbook of Innovation*, Oxford: Oxford University Press.

Fagerberg J., Fosaas M., Sapprasert K. [2012] “Innovation: Exploring the knowledge base”, *Research Policy*, vol. 41, pp. 1132–1153.

Ferleger L., Lazonick W. [1994] “The role of US government in the emergence of the commercial airline industry”, *Unpublished research note,* University of Massachusetts, October.

Fiott D. [2014] “The three effects of dual-use: Firms, capabilities, and governance”, *European Union Institute for Security Studies*, Brief Issue, n°21.

Flight International [2015] Top 100 Aerospace Companies Special Report, *Flightglobal*, September 15-21.

Fligstein N. [1990] *The transformation of corporate control*, Cambridge: Harvard University Press.

Fligstein N., Shin T. [2007] “Shareholder Value and the Transformation of the U.S. Economy, 1984–2000”, *Sociological Forum*, vol. 22, n°4, pp. 399-424.

Forsberg D. [2012] “Aircraft Retirement Trends & Outlook”, *Avolon,* September.

Francis J. G., Pevzner, A. F. [2006] “Airbus and Boeing: Strengths and Limitations of Strong States”, *Political Science Quarterly*, vol. 121, n°4, pp. 629-651.

Freeman C. [1974] *The Economics of Industrial Innovation*, Harmondsworth: Penguin.

Freeman C. [1995] “The 'National System of Innovation' in historical perspective”, *Cambridge Journal of Economics*, vol.19, pp.5-24.

Freeman R. [1998] “Boeing layoffs usher in new phase of production collapse”, *EIR Economics*, vol. 25, n°50, pp. 4-7.

Frenken K., Leydesdorff L. [2000] “Scaling trajectories in civil aircraft 1913–1997”, *Research Policy*, vol. 29, n°3, pp. 331-348.

Freyssenet M. [2003] Origines et Limites de la Diversité des Modèles Productifs Questions de Recherche et D’organisation de la Recherche, *Onzième Rencontre Internationale Du Gerpisa*, June 11-13, Paris.

Freytag P., Clarke A. H., Evald M. R. [2012] “Reconsidering outsourcing solutions”, *European Management Journal*, vol. 30, n°2, pp. 99-110.

Fridie W. [1961] “Wage chronology No. 40: The Boeing Co. Washington plants, 1936-61”, *Monthly Labor Review*, vol. 84, n°4, pp. 754-764.

Frigant V., Kechidi M., Talbot D. [2006] L*es territoires de l’aéronautique: EADS entre mondialisation et ancrage*, Paris: L’Harmattan.

Froud J., Johal S., Leaver A., Williams K. [2006] *Financialization and Strategy Narrative and Numbers*, London: Routledge.

Froud J., Johal S., Leaver A., Williams K. [2014] "Financialization across the Pacific: Manufacturing cost ratios, supply chains and power", Critical Perspectives on Accounting, vol. 25, n°1, pp. 46-57.

Fujimoto T. [1999] *The Evolution of a Manufacturing System at Toyota*, Oxford: Oxford University Press.

Fujimoto T. [1999] "Evolution of Firms and Industries" *Evolutionary & Institutional Economics Review*, vol. 9, n°1, pp. 1-10.

Gaffard J. [2013] "Re-Industrialising The Eurozone", *OFCE Document de travail*, 2013-08.

García-Castro R., Balasubramanian N., Lieberman M. B. [2013] *Measuring Value Creation and Appropriation in Firms: Application of the VCA Model*, available at SSRN: http://ssrn.com/abstract=2381822.

Gereffi G., Humphrey J., Sturgeon T. [2005] "The governance of global value chains", *Review of International Political Economy*, vol. 12, n°1, pp. 78-104.

Gholz E. [2003] "Systems Integration in the US Defence Industry: Who Does It and Why Is It Important?" in Prencipe A., Davies A., Hobday M. eds., *The Business of Systems Integration*, Oxford: Oxford University Press, pp. 279-306.

Gillett D., Stekler H. O. [1995] "Introducing Technologically Advanced Products: Strategies in the Commercial Aircraft Industry", *Technological Forecasting and Social Change*, vol. 48 n°2, pp. 129-141.

Goldstein A. [2012] "Revenge of the Managers: Labor Cost-Cutting and the Paradoxical Resurgence of Managerialism in the Shareholder Value Era, 1984 to 2001", *American Sociological Review*, vol. 77, n°2, pp. 268-294.

Gonzàlez X., Miles-Touya D., Pazò C. [2012] "R&D, Worker Training, and Innovation: Firm-level evidence". *Universidade de Vigo, Departamento de Economìa Aplicada*, Working Paper n°1203.

GRA [1990] *An Economic and Financial Review of Airbus Industrie*, Prepared by Gellman Research Associates Inc., Jenkintown, September 4.

Graham J. R., Harvey C. R., Rajgopal S. [2006] "Value Destruction and Financial Reporting Decisions", *Financial Analysts Journal*, vol. 62, n°6, pp. 27-39.

Grahl J., Teague P. [2000] "The Régulation School, the employment relation and financialization", *Economy & Society,* vol. 29 n°1, pp. 160-178.

Granstrand O., Patel P., Pavitt, K. [1997] "Multitechnology corporations: Why they have 'distributed' rather than 'distinctive core' capabilities", *California Management Review*, vol. 39, n°4, pp. 8-25.

Hall B. H. [2009] "The financing of innovative firms", *EIB Papers*, vol. 14, n°2, pp. 8-28.

Hall B. H., Rosenberg N. [2010] *Handbook of the Economics of Innovation Volume 1 & 2*, Oxford: Elsevier.

Hall B. H., Ziedonis R. H. [2010] "The patent paradox revisited: an empirical study of patenting in the U.S. semiconductor industry, 1979–1995", RAND Journal of Economics, vol. 32, n°1, pp. 101-128.

Hall P. A., Soskice D. [2001] *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, Oxford: Oxford University Press.

Hansen P. [2014] "From Finance Capitalism to Financialization: A Cultural and Narrative Perspective on 150 Years of Financial History", *Enterprise & Society*, vol. 15, n°4, pp. 605-642.

Hartley K. [1965] "The Learning Curve and its Application to the Aircraft Industry", *Journal of Industrial Economics*, vol. 13, n°2, pp. 122-128.

Hart-Smith L. J. [2001] "Out-sourced Profits: The Cornerstone of Successful Subcontracting", Paper presented at *Boeing Third Annual Technical Excellence (TATE) Symposium*, St. Louis, February 14-15.

Haslam C., Andersson T., Tsitsianis N., Yin Y.P. [2012] "Business Models Redefined: Strategy in a Financialized World", paper submitted to the British Academy of Management conference.

Hayward K. [1975] "Politics and European Aerospace Collaboration the A300 Airbus", *Journal of Common Market Studies*, vol. 14, n°4, pp. 354-367.

Hickie D. [2006] "Knowledge and Competitiveness in the Aerospace Industry: The Cases of Toulouse, Seattle and North-west England", *European Planning Studies*, vol. 14, n°5, pp. 697-716.

Hoag T. A. [2000] "Planes, Rockets, Profits? Supply Chain Strategy in the Aerospace Industry", 15.769 Manufacturing Strategy Term Paper, *MIT Sloan School of Management*, May 8.

Hobday M., Davies A., Prencipe A. [2005] "Systems integration: a core capability of the modern corporation", *Industrial and Corporate Change*, vol. 14, n°6, pp. 1109-1143.

Hoecht A., Trott P. [2006] "Innovation risks of strategic outsourcing", *Technovation*, vol. 26, n°5-6, pp. 672-681.

IATA [2015] "World Air Transport Statistics 59th Edition", *International Air Transport Association*, Montreal.

ICAO [2014] "World Aviation and the World Economy", *ICAO Facts and Figures*, retrieved March 1, from http://www.icao.int/sustainability/Pages/Facts-Figures_WorldEconomyData.aspx.

Igalens J., Vicens C. [2006] "Les mutations dans le secteur aéronautique : Le cas d'Airbus en Midi-Pyrénées", *Monitoring Innovative Restructuring in Europe*, September.

Imberman W. [2001] "Why Engineers Strike- The Boeing Story", *Business Horizons*, November-December, pp.35-44.

INSEE [2010] “L'aéronautique et l'espace en Aquitaine et Midi-Pyrénées- Régions d'Aerospace Valley”, *Institut National de la Statistique et des Etudes Economiques*, December.

Irwin D. A., Pavcnik N. [2004] “Airbus versus Boeing revisited: international competition in the aircraft market”, *Journal of International Economics*, vol. 64, n°2, pp. 223-245.

Jacobides M. G., Knudsen T., Augier M. [2006] “Benefiting from innovation: Value creation, value appropriation and the role of industry architectures”, *Research Policy*, vol. 35, n°8, pp. 1200-1221.

Jacoby S. M. [2007] *The Embedded Corporation*, Princeton: Princeton University Press.

Jacoby S. M. [2008] *Finance and Labor: Perspectives on Risk, Inequality, and Democracy*, October 1, available at SSRN: http://ssrn.com/abstract=1020843.

Jalabert !g; [1974] *Les industries aéronautiques et spatiales en France*, Toulouse: Privat.

Jensen M. C. [1986] “Agency cost of free cash flow, corporate finance, and takeovers”, *American Economic Review*, vol. 76, n°2, pp. 323-329.

Jensen M. C., Meckling W. H. [1986] “Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure”, *Journal of Financial Economics*, vol. 3, n°4, pp. 305-360.

Jessop B. [2011] “Rethinking the diversity of capitalism: varieties of capitalism, variegated capitalism, and the world market”, in Wood G., Lane C., eds., *Capitalist Diversity and Diversity within Capitalism*, London: Routledge, pp. 209-237.

Johnson S. B. [1997] “Three Approaches to Big Technology: Operations Research, Systems Engineering, and Project Management” *Technology and Culture*, vol. 38, n°4, pp. 891–919.

Johnson S. B. [2003] “Systems Integration and the Social Solution of Technical Problems in Complex Systems” in Prencipe A., Davies A., Hobday M. eds., *The Business of Systems Integration*, Oxford: Oxford University Press, pp. 35-55.

Jones W. D. Jr. [1990] *Arming the Eagle: A History of US Weapons Acquisition Since 1775,* Fort Belvoir, VA: Defense Systems Management College Press.

Jürgens U., Naumann K., Rupp J. [2000] “Shareholder value in an adverse environment: The German case”, *Economy & Society*, vol. 29, n°1, pp. 54-79.

Kakabadse C., Kakabadse N. K. [2003] “Trends in Outsourcing: Contrasting USA and Europe”, *European Management Journal*, vol. 20, n°2, pp. 189-198.

Kawagoe M. [2008] “Air Transport Deregulation in the EU: Study from the Europeanization Perspective”, Paper for Presentation at the *IPSA RC-3 Symposium on “European Integration between the Past and the Present”*, Hokkaido University, Sapporo, Japan, September 6.

Kechidi M. [2008] “Modularité, firme-pivot et innovations: quels impacts sur l’organisation de la supply chain chez Airbus?”, *7èmes Rencontres Internationales de la Recherche en Logistique*, Avignon, September 24-26.

Kechidi M., Talbot D. [2013] "Les Mutations de l'Industrie Aéronautique Civile Française : Concentration, Externalisation et Firme-Pivot", *Entreprises et Histoire*, n°73, pp. 75-88.

Kleiner M.M., Leonard J.S., Pilarski A.M. [2002] "How Industrial Relations Affects Plant Performance: The Case of Commercial Aircraft Manufacturing", *Industrial and Labor Relations Review*, vol. 55, n°2, pp. 195-218.

Koenig C., Thietart R. [1988] "Managers, Engineers and Government: The Emergence of the Mutual Organization in the European Aerospace Industry", *Technology in Society*, vol. 10, pp. 45-69.

Kogut B., Zander U. [1992] "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology", *Organization Science*, vol. 3, n°3, pp. 383-397.

Kortum S., Lerner J. [1999] "What is behind the recent surge in patenting?", *Research Policy*, vol. 28, n°1, pp. 1-22.

KPMG [2012] "Aerospace & Defense 2012 Industry Outlook Survey", *KPMG LLP*, Delaware.

Krafft J. [2006] "Introduction: What do we know about Industrial Dynamics?", *Revue de l'OFCE*, vol. 2006/5, n°97bis, pp. 13-19.

Krippner G. R. [2005] "The financialization of the American economy", *Socio-Economic Review*, vol. 3, n°2, pp. 173-208.

Kronemer A., Henneberger J.E. [1993] "Productivity in aircraft manufacturing", *Monthly Labor Review*, June, pp.24-33.

Ladipo D., Wilkinson F. [2001] "More pressure, less protection", in Burchell B., Ladipo D., Wilkinson F. eds., *Job Insecurity and Work Intensification*, London: Routledge, pp. 8-38.

Langlois R. N. [2003] "The vanishing hand: the changing dynamics of industrial capitalism", *Industrial and Corporate Change*, vol. 12, n°2, pp. 351-385.

Lawrence P. [2001] *Aerospace Strategic Trade: How the US Subsidizes the Large Commercial Aircraft Industry*, London: Ashgate Publishing Limited.

Lawrence P., Braddon D. [1999] *Strategic Issues in European Aerospace*, London: Ashgate Publishing Limited.

Lawrence R. Z., Edwards L. [2013] "US Employment Deindustrialization: Insights from History and the International Experience", *Peterson Institute for International Economics Policy Briefs*, n°PB13-27.

Lazonick W. [1990a] "Organizational Capabilities in American Industry: The Rise and Decline of Managerial Capitalism" *Business and Economic History,* vol. 19, pp. 35-54.

Lazonick W. [1990b] *Competitive Advantage on the Shop Floor*, Boston: Harvard University Press.

Lazonick W. [2002] "Innovative Enterprise and Historical Transformation", *Enterprise & Society*, vol. 3, pp. 3-47.

Lazonick W. [2005] “The Innovative Firm”, in Fagerberg J., Mowery D., Nelson, R. eds., *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, pp. 29-55.

Lazonick W. [2007] “The US Stock Market and the Governance of Innovative Enterprise”, *Industrial and Corporate Change*, vol. 16, n°6, pp. 983-1035.

Lazonick W. [2009] “The New Economy Business Model and the Crisis of U.S. Capitalism”, *Capitalism and Society*, vol. 4, n°2, article 4.

Lazonick W. [2010a] “The Chandlerian corporation and the theory of innovative enterprise”, *Industrial and Corporate Change*, vol. 19, n°2, pp. 317-349.

Lazonick W. [2010b] “Innovative Business Models and Varieties of Capitalism: Financialization of the U.S. Corporation”, *Business History Review*, vol. 84, pp. 675-702.

Lazonick W. [2012] “The Innovative Enterprise and the Developmental State: Toward an Economics of “Organizational Success”” paper prepared for the annual conference of the Institute for New Economic Thinking, Breton Woods, NH, April 8- 11, 2011, and revised for the conference on Finance, Business Models, and Sustainable Prosperity, Ford Foundation, New York, NY, December 6-7, 2012.

Lazonick W. [2013] “The Theory of Innovative Enterprise: A Foundation of Economic Analysis” *AIR Working Paper Series* #13-02/01.

Lazonick W. [2014a] “Profits Without Prosperity”, *Harvard Business Review*, September, pp. 3-11.

Lazonick W. [2014b] “Taking Stock: Why Executive Pay Results in an Unstable and Inequitable Economy”, *Roosevelt Institute White Paper*, June 5.

Lazonick W. [2015a] “Stock buybacks: From retain-and reinvest to downsize-and-distribute”, *Center for Effective Public Management at Brookings*, April.

Lazonick W. [2015b] *Comments on the draft of the 2014-2015 revision of the OECD Principles of Corporate Governance*, January 4.

Lazonick W., Prencipe A. [2005] “Dynamic capabilities and sustained innovation: strategic control and financial commitment at Rolls-Royce plc”, *Industrial and Corporate Change*, vol. 14, n°3, pp. 501-542.

Lazonick W., Mazzucato M. [2013] “The risk-reward nexus in the innovation-inequality relationship: who takes the risks? Who gets the rewards?”, *Industrial and Corporate Change*, vol. 22, n°4, pp. 1093-1128.

Lazonick W., O’Sullivan, M. [2000] “Maximizing Shareholder Value: A New Ideology for Corporate Governance”, *Economy & Society*, vol. 29, n°1, pp. 13-35.

Learned E., Christensen C., Andrews K., Guth W. [1969] *Business Policy: Text and Cases*, Homewood: R. D. Irwin.

Lecocq X., Demil B., Warnier V. [2006] “Le business model, un outil d’analyse stratégique”, *L’Expansion Management Review*, n°123, pp. 96-109.

Levinson M. [2012] “On the Contrary: Manufacturing the Future: Why Reindustrialization Is the Road to Recovery”, *New Labor Forum*, September.

Lieberman M. B., Balasubramanian N. [2007] *Measuring Value Creation and Its Distribution Among Stakeholders of the Firm,* available at SSRN: http://ssrn.com/abstract=2382099.

Lippert I., Huzzard T., Jürgens U., Lazonick W. [2014] *Corporate Governance, Employee Voice, and Work Organization, Sustaining High-Road Jobs in the Automotive Supply Industry*, Oxford: Oxford University Press.

Locke R. M., Thelen K. [1995] “Apples and Oranges Revisited: Contextualized Comparisons and the Study of Comparative Labor Politics”, *Politics & Society*, vol. 23, n°3, pp. 337-367.

Lonsdale C., Cox A. [2000] “The historical development of outsourcing: the latest fad?”, *Industrial Management & Data Systems*, vol. 100, n°9, pp. 444-450.

Lueke S. R. [2014] *Employer Strategies in a Changing Slow-Growth Economy; Dealing with Organized Labor: The Boeing Blueprint*, Ius Laboris United States - FordHarrison LLP.

Lung Y. [2005] “The link between the diversity of productive models and the variety of capitalisms A review of the literature and contextualization using the car industry as a case study” *Cahiers du Groupement de Recherches Economiques et Sociales*, IFReDE Université Montesquieu-Bordeaux 4 & LEREPS Université des Sciences Sociales Toulouse 1, n°2005-17.

Lung Y. [2008] “Modèles de firme et formes du capitalisme: Penser la diversité comme agenda de recherche pour la TR” *Revue de la régulation*, n°43, pp. 1-23.

Lynn M. [1995] *Birds of Prey: Boeing vs. Airbus: A Battle for the Skies*, London: Reed International Books Ltd..

MacPherson A., Pritchard D. [2003] “The international decentralisation of US commercial aircraft production: implications for US employment and trade”, *Futures*, vol. 35, n°3, pp. 221-238.

MacPherson A., Pritchard D. [2007] “Boeing’s Diffusion of Commercial Aircraft Technology to Japan: Surrendering the U.S. Industry for Foreign Financial Support”, *Journal of Labor Research*, vol.28, n°3, pp. 552-566.

Magretta J. [2002] “Why Business Models Matter”, *Harvard Business Review*, May, 86-92.

Mahadevan B. [2000] “Business models for Internet-based e-commerce: An anatomy”, *California Management Review*, vol.42, n°4, pp.55-69.

Malerba F. [2004] *Sectoral Systems of Innovation: Concepts, Issues and Analyses of Six Major Sectors in Europe*, Cambridge: Cambridge University Press.

Martin R. [2003] “The Fundamental Problem with Stock-Based Compensation”, *Rotman Management*.

Mauboussin M. J. [2010] "It's All About Managing for Value Comments based on a presentation at the CFO Executive Summit", *Legg Mason Capital Management*, June 11.

Mazzucato M. [2011] *The Entrepreneurial State*, London: Demos.

McGuire S. [2007] "The United States, Japan and the aerospace industry: from capture to competitor?", *The Pacific Review*, vol.20, n°3, pp.329-350.

McIntyre I. [1992] *Dogfight: The Transatlantic Battle over Airbus*, Westport: Praeger.

Metcalfe J.S., Ramlogan R. [2006] "Restless Capitalism: A Complexity Perspective on Modern Capitalist Economies" in Garnsey, E., McGlade, J. eds., *Complexity and Evolution*, Cheltenham: Edward Elgar.

Milberg W. [2008] "Shifting sources and uses of profits: sustaining US financialization with global value chains", *Economy & Society*, vol. 37, n°3, pp. 420-451.

Milberg W. [2010] *Global Value Chains: Governance and Policy Implications*, Post-Hearing Statement by William Milberg to the U.S. International Trade Commission Pursuant to Investigation No. 332-325 The Economic Effects of Significant Import Restraints: Seventh Update, December, 20.

Milberg W., Winkler D. [2010] "Financialization and the Dynamics of Offshoring in the USA", *Cambridge Journal of Economics* vol. 34, n°2, pp. 275-293.

Milkman R. [2013] "Back to the Future? US Labour in the New Gilded Age", *British Journal of Industrial Relations*, vol. 51, n°4, pp. 645-665.

MIT [2013] *A Preview of the MIT Taskforce on Innovation and Production Reports*, Cambridge: MIT Press.

MIT Labor Aerospace Research Agenda and Lean Aerospace Initiative [2001] *Developing a 21st Century Aerospace Workforce,* White Paper, November.

Mitchell D., Coles C. [2003] "The ultimate competitive advantage of continuing business model innovation", *Journal of Business Strategy*, vol. 24 n°5 pp. 15-21.

Monks R. A. [2005]" Governing the multinational enterprise: emergence of the global shareowner", in Chandler A. D., Mazlish B., eds., *Leviathans: Multinational Corporations and the New Global History*, Cambridge: Cambridge University Press.

Monroy C. R., Vilana Arto J. R. [2010] "Analysis of global manufacturing virtual networks in the aeronautical industry", *International Journal of Production Economics*, vol. 126 n°2 pp. 314-323.

Montalban M., Sakinc M. E. [2013] "Financialization and productive models in the pharmaceutical industry" *Industrial and Corporate Change*, vol. 22, n°4, pp. 981–1030.

Monthly Labor Review [1964] "Wage Chronology: The Boeing Co. (Washington Plants)", *Monthly Labor Review*, August, pp. 900-903.

Morin F. [2006] “Le capitalisme de marché financier et l’asservissement du cognitive”, *Cahiers du Groupement de Recherches Economiques et Sociales*, IFReDE Université Montesquieu-Bordeaux 4 & LEREPS Université des Sciences Sociales Toulouse 1, n°2006-5.

Morris M., Schindehutte, M., Allen J. [2005] “The entrepreneur ’s business model: toward a unified perspective”, *Journal of Business Research*, vol. 58, pp. 726-735.

Moura S. [2007] L’impossible banalisation de l’industrie de la défense, thèse de doctorat ès sciences économiques, *Université Montesquieu Bordeaux IV*.

Mowery D. [1988] *International Collaborative Ventures in U.S. Manufacturing*, Pensacola: Ballinger Publishing Company.

Mowery D. [1992] “Finance and Corporate Evolution in Five Industrial Economies, 1900-1950”, *Industrial and Corporate Change,* vol.1, n°1, pp.1-36.

Mowery D. [2009] “*Plus ça change*: Industrial R&D in the “third industrial revolution””, *Industrial and Corporate Change*, vol.18, n°1, pp.1-50.

Mowery D., Rosenberg N. [1982] “Technical Change in the Commercial Aircraft Industry, 1925-1975”, in Nelson R. R. ed., *Government and Technical Change: A Cross-Industry Analysis*, Oxford: Pergamon Press.

Mowery D., Rosenberg N. [1989] *Technology and the Pursuit of Economic Growth*, Cambridge: Cambridge University Press.

Mowery D., Nelson R. R. [1999] *Sources of Industrial Leadership: Studies of Seven Industries*, Cambridge: Cambridge University Press.

Mueller C.B., Van Deusen C., Hornsby J.S. [1998] “Successful Downsizing: The Case of the Boeing Reemployment Program”, Journal of Leadership & Organizational Studies, vol.5, n°3, pp.152-161.

Muller P. [1988] *Airbus, l’ambition européenne, logique d’Etat, logique de marché*, Paris : L’Harmattan.

Muslu V. [2010] “Executive Directors, Pay Disclosures, and Incentive Compensation in Large European Companies” *Journal of Accounting, Auditing & Finance*, vol. 25, n°4, pp. 569-605.

Nelson R.R. [1991] “Why do firms differ, and how does it matter?”, *Strategic Management Journal*, vol. 12, Special Issue, pp. 61-74.

Nelson R.R. [2008] “Why do firms differ, and how does it matter? A Revisitation”, *Seoul Journal of Economics*, vol. 21, n°4, pp. 607-619.

Nelson R.R., Winter S.G. [1982] *An Evolutionary Theory of Economic Change*, Cambridge: Belknap Press of Harvard University Press.

Newhouse J. [2007] *Boeing versus Airbus: The Inside Story of the Greatest International Competition in Business*, New York: Vintage Books.

OECD [1999] *OECD Principles of Corporate Governance*, Paris.

OECD [2001] "Using Patent Counts for Cross-Country Comparisons of Technology Output", *STI Review*, n°27, pp. 129-146.

OECD [2007] *Staying Competitive in the Global Economy: Moving Up the Value Chain*, Paris.

OECD [2015] "Main Science and Technology Indicators", *OECD Publishing*, vol. 2015, n°1, available at http://dx.doi.org/10.1787/msti-v2015-1-en.

Orhangazi Ö. [2008] "Financialization and capital accumulation in the non-financial corporate sector: a theoretical and empirical investigation on the U.S. economy, 1973-2003", *Cambridge Journal of Economics*, vol. 32, n°6, pp. 863-886.

Osterman P., Kochan T. A., Locke R., Piore M. J. [2001] *Working in America, A Blueprint for the New Labor Market*, Cambridge: The MIT Press.

Ostrower J. [2011] "Analysis: Boeing 787 historic pricing discounts put pressure on programme's profitability", *Flight International of Reed Business Information*, January 4th.

O'Sullivan M. [2000] "The innovative enterprise and corporate governance", *Cambridge Journal of Economics*, vol. 24, pp. 393-416.

O'Sullivan M. [2007] "Funding New Industries: A Historical Perspective on the Financing Role of the U.S. Stock Market in the Twentieth Century", in Lamoreaux N. R., Sokoloff K. L., eds., *Financing Innovation in the United States, 1870 to the Present*, Cambridge: MIT Press, pp. 163-216.

Palley T. I. [2007] "Financialization: What It Is and Why It Matters", *The Levy Economics Institute Working Paper*, n°525.

Pavcnik N. [2002] "Trade Disputes in the Commercial Aircraft Industry", *The World Economy*, vol. 25, n°5, pp. 733-751.

Pavitt K. [2003] "Specialization and Systems Integration: Where Manufacture and Services Still Meet" in Prencipe A., Davies A., Hobday M. eds., *The Business of Systems Integration*, Oxford: Oxford University Press, pp. 78-91.

Penrose [1959] *The Theory of the Growth of the Firm*, New York: John Wiley and Sons.

Penrose E. [1960] "The Growth of the Firm- A Case Study: The Hercules Powder Company", *Business History Review*, vol. 34, n°S, pp. 1-23.

Penrose E. [1989] ''History, the Social Sciences and Economic 'Theory,' with Special Reference to Multinational Enterprise'', in Teichova A., Lévy-Leboyer M., Nussbaum H. eds., *Historical Studies in International Corporate Business*, Cambridge: Cambridge University Press, pp. 7-13.

Peterson K. [2011] "A wing and a prayer: outsourcing at Boeing", *Reuters Special Report*, January, 20.

Pierce J. R., Schott P. K. [2012] "The Surprisingly Swift Decline of U.S. Manufacturing Employment", *NBER Working Paper*, n°18655.

Pisano G. [2010] “The evolution of science-based business: innovating how we innovate”, *Industrial and Corporate Change*, vol. 19, n°2, pp. 465-482.

Pisano G., Shih W. C. [2009] “Restoring American Competitiveness”, *Harvard Business Review*, July-August, pp. 114-125.

Pitelis C. N. [2009] “Edith Penrose’s ‘The Theory of the Growth of the Firm’ Fifty Years Later”, Penrose E., *The Theory of the Growth of the Firm Fourth Edition*, Oxford: Oxford University Press, pp. ix-xlvi.

PMI [2009] “The Growth of Aircraft Manufacturing in Low-wage Economies 2005-2009”, *PMI Media Limited*, Hove.

Porter M. E. [2001] “Strategy and the Internet”, *Harvard Business Review*, March, pp. 63-78.

Prahalad C.K., Hamel G. [1990] “The Core Competence of the Corporation”, *Harvard Business Review*, May-June, pp. 1-15.

Prencipe A. [2001] “Exploiting and Nurturing In-House Technological Capabilities: Lessons from the Aerospace Industry” *International Journal of Innovation Management*, vol. 5, n°3, pp. 299-321.

Prencipe A., Davies A., Hobday M. [2003] *The Business of Systems Integration*, Oxford: Oxford University Press.

Pritchard D. [2002] *Global Decentralization of Commercial Aircraft Production*, Unpublished Dissertation, State University of New York at Buffalo, USA.

Pritchard D., MacPherson A. [2004] “Industrial Subsidies and the Politics of World Trade: The Case of the Boeing 7e7”, *The Industrial Geographer*, vol. 1, n°2, pp. 57-73.

Quélin B., Duhamel F. [2003] “Bringing Together Strategic Outsourcing and Corporate Strategy: Outsourcing Motives and Risks”, *European Management Journal*, vol. 21, n°5, pp. 647-661.

Quinn J. B. [1999] “Strategic Outsourcing- Leveraging Knowledge Capabilities”, *Sloan Management Review*, vol. 40, n°4, pp. 9-21.

Quinn J. B. [1999] “Outsourcing Innovation: The New Engine of Growth”, *Sloan Management Review*, vol. 41, n°4, pp. 13-28.

Rae J. B. [1965] “Financial problems of the American aircraft industry, 1906-1940”, *Business History Review*, vol. 39, n°1, pp. 99-114.

Rédis J. [2007] “Le Business model : notion polymorphe ou concept gigogne ?”, *5ème Congrès de l’Académie de l’entrepreneuriat*, Sherbrooke, October 3-5.

Richardson G.B. [1972] “The organization of industry”, *The Economic Journal*, vol. 82, pp. 883-896.

Robertson P. L., Langlois R. N. [1995] “Innovation, networks, and vertical integration” *Research Policy*, vol. 24, n°4, pp. 543-562.

Rodgers E. [1996] *Flying High: The Story of Boeing and the Rise of the Jetliner Industry*, New York: Atlantic Monthly Press.

Rosenberg N. [1976] *Perspectives on Technology*, Cambridge: Cambridge University Press.

Rosenberg N. [1982] *Inside the Black Box Technology and Economics*, Cambridge: Cambridge University Press.

Rowthorn R. E., Ramaswamy R. [1998] "Growth, Trade and Deindustrialization", *IMF Working Paper*, n°98/60.

Rowthorn R. E., Wells J. R. [1987] *Deindustrialization and Foreign Trade*, Cambridge: Cambridge University Press.

Rubery J., Earnshaw J., Marchington M., Cooke F. L., Vincent S. [2002] "Changing Organizational Forms and the Employment Relationship", *Journal of Management Studies*, vol. 39, n°5, pp. 645-672.

Ruttan V. W. [2006] *Is War Necessary for Economic Growth? Military Procurement and Technology Development*, Oxford: Oxford University Press.

Sakai T. [2004] "The Fall of Boeing and Japan's Airline Industry", *The Asia-Pacific Journal*, vol. 2, n°6.

Sakinç, M.E. [2012] "Share Repurchases in Europe", *Unpublished research note.*

Sako M. [2004] "Supplier development at Honda, Nissan and Toyota: comparative case studies of organizational capability enhancement", *Industrial and Corporate Change*, vol. 13, n°2, pp. 281-308.

Sako M. [2005] "Outsourcing and Offshoring: Key Trends and Issues, Background Paper prepared for the Emerging Markets Forum", *Said Business School*, Oxford, November.

Sako M. [2006] *Shifting Boundaries of the Firm: Japanese Company–Japanese Labour*, Oxford: Oxford University Press.

Sako M. [2008] "Do industries matter?", *Labour Economics*, vol. 15, n°4, pp. 674-687.

Salento A., Masino G., Berdicchia D. [2013] "Financialization and Organizational Changes in Multinational Enterprises", *Revue d'économie industrielle*, n°144/4, pp. 145-176.

Sapolsky H. M. [2003] "Inventing Systems Integration" in Prencipe A., Davies A., Hobday M. eds., *The Business of Systems Integration*, Oxford: Oxford University Press, pp. 15-34.

Schumpeter J. A. [1968] *The Theory of Economic Development*, Cambridge: Harvard University Press.

Seddon P. B., Lewis G. P. [2003] "Strategy and Business Models: What's the Difference?", *7th Pacific Asia Conference on Information Systems*, 10-13 July 2003, Adelaide, South Australia.

Sherry L., Sarsfield L. [2002] "Redirecting R&D in the Commercial Aircraft Supply Chain", *RAND Issue Papers*, RAND's Science and Technology Policy Institute.

Shin J. [2011] “NASA Aeronautics Research”, *NASA Alumni League (NAL) Discussion*, March 4.

Shin T. [2012] “CEO Compensation and Shareholder Value Orientation Among Large US Firms”, *The Economic and Social Review*, vol. 43, n°4, pp. 535-559.

Sorscher S. [2002] “Challenge in Aerospace Leadership”, *SPEEA Business Critique*.

Sorscher S. [2011] “Problem-solving culture in Boeing Commercial Airplanes” *Unpublished research note.*

Starosta G. [2010] “Global Commodity Chains and the Marxian Law of Value”, Antipode, vol. 42, n°2, pp. 433-465.

Sturgeon T. J. [2002] “Modular production networks: A new American model of industrial organization”, *Industrial and Corporate Change*, vol. 11, n°3, pp. 451-496.

Sturgeon T. J. [2008], “From Commodity Chains to Value Chains: Interdisciplinary Theory Building in an Age of Globalization”, *Massachusetts Institute of Technology Industrial Performance Center Working Paper Series*, MIT-IPC-08-001, January.

Szodruch J., Grimme W., Blumrich F., Schmid R. [2011] “Next generation single-aisle aircraft - Requirements and technological solutions”, *Journal of Air Transport Management*, vol. 17, n°1, pp. 33-39.

Tang C. S., Zimmerman J. D. [2009] “Managing New Product Development and Supply Chain Risks: The Boeing 787 Case”, *Supply Chain Forum*, vol. 10, n°2, pp. 74-86.

Tassey G. [2010] “Rationales and mechanisms for revitalizing US manufacturing R&D strategies”, *The Journal of Technology Transfer*, vol. 35, n°3, pp. 283-333.

Teece D. [1986] “Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy”, *Research Policy*, vol. 15, n°6, pp. 285-305.

Teece D. [1996] “Firm organization, industrial structure, and technological innovation”, *Journal of Economic Behavior & Organization*, vol. 31, pp. 193-224.

Teece D. [2009] *Dynamic Capabilities and Strategic Management*, Oxford: Oxford University Press.

Teece D. [2010a] “Alfred Chandler and “capabilities” theories of strategy and management”, *Industrial and Corporate Change*, vol. 19, n°2, pp. 297-316.

Teece D. [2010b] “Business models, business strategy and innovation”, *Long Range Planning*, n°43: pp. 172-194.

Teece D., Pisano G., Shuen A. [1997] “Dynamic Capabilities and Strategic Management”, *Strategic Management Journal*, vol. 18, n°7, pp. 509-533.

The Center for Security Policy [2010] “EADS/Airbus Government Ownership, Protection, Intervention & Subsidies”, *Center for Security Policy - The Occasional Paper Series*, Washington D.C., September 1.

Thomson P. [2003] “Disconnected capitalism: or why employers can’t keep their side of the bargain”, *Work, Employment and Society*, vol. 17, n°2, pp. 359-378.

Thomson P. [2011] “The trouble with HRM”, *Human Resource Management Journal*, vol. 21, n°4, pp. 355-367.

Thornton D. W. [1995] *Airbus Industrie: The Politics of an International Industrial Collaboration*, London: Macmillan.

Todd D., Simpson J. [1986] *The World Aircraft Industry*, Westport: Greenwood Publishing Group.

Tortoriello R. [2010] “Industry Surveys: Aerospace & Defense”, *Standard & Poor’s Industry Surveys*, New York: The McGraw-Hill Companies.

Tyson L. A., Chin P. [1993] “Industrial Policy and Trade Management in the Commercial Aircraft Industry” in Tyson L. A., *Who's Bashing Whom: Trade Conflict in High-Technology Industries*, Washington D.C.: Peterson Institute for International Economics.

US Aerospace Commission [2002] “The Final Report of the Commission on the Future of the United States Aerospace Industry”, November.

US Congress [1991] “Chapter 8. Government Support of the Large Commercial Aircraft Industries of Japan, Europe, and the United States” in *Competing Economies: America, Europe, and the Pacific Rim*, U.S. Congress, Office of Technology Assessment, Washington, DC: U.S. Government Printing Office.

Visser J. [2006] “Union membership statistics in 24 countries”, *Monthly Labor Review*, January, pp. 38-49.

Wade R. H. [2012] “The Mystery of U.S. Industrial Policy: The Developmental State in Disguise”, *Research note*, April 10.

Wagner M., Norris G. [2009] *Boeing 787 Dreamliner*, Minneapolis: Zenith Press.

Whitley R. [1999] *Divergent Capitalisms: The Social Structuring and Change of Business Systems*, Oxford: Oxford University Press.

Williams K. [2000] “From shareholder value to present-day capitalism”, *Economy & Society*, vol. 29, n°1, pp. 1-12.

Williams T., Maull R., Ellis B. [2002] “Demand chain management theory: constraints and development from global aerospace supply webs”, *Journal of Operations Management*, vol. 20, n°6, pp. 691-706.

Williamson O.E. [1975] *Markets and Hierarchies: Analysis and Antitrust Implications*, New York: Free Press.

Williamson O.E. [1981] “The Economics of Organization: The Transaction Cost Approach”, *American Journal of Sociology*, vol. 87, n°3, pp. 548-577.

Winter S. G. [2003] “Understanding Dynamic Capabilities”, *Strategic Management Journal*, vol. 24, n°10, pp. 991-995.

Wise R., Baumgartner P. [1999] “Go Downstream: The New Profit Imperative in Manufacturing” *Harvard Business Review*, September-October, pp. 133–141.

Wright T. P. [1936] “Factors Affecting the Cost of Airplanes”, *Journal of the Aeronautical Sciences*, vol. 3 pp. 122-128.

WTO [2010] “European Communities and Certain Member States –Measures Affecting Trade in Large Civil Aircraft, Report of the Panel”, *World Trade Organization*, WT/DS316/R, June 30.

WTO [2011a] “United States – Measures Affecting Trade in Large Civil Aircraft (Second Complaint), Report of the Panel”, *World Trade Organization*, WT/DS353/R, March 31.

WTO [2011b] “European Communities and Certain Member States – Measures Affecting Trade in Large Civil Aircraft, Report of the Appellate Body”, *World Trade Organization*, WT/DS316/R, May 18.

WTO [2012] “United States – Measures Affecting Trade in Large Civil Aircraft (Second Complaint), Report of the Appellate Body”, *World Trade Organization*, WT/DS353/R, March 12.

Yelle L. E. [1979] “The Learning Curve: Historical Review and Comprehensive Survey”, *Decision Sciences*, vol. 10, n°2, pp. 302-328.

Yin R. K. [2003] “Case Study Research, Design and Methods”, *Applied Social Research Methods Series*, vol. 5, Thousand Oaks: SAGE Publications.

Zirpoli F., Becker M. C. [2011] “What Happens When You Outsource Too Much?”, *MIT Sloan Management Review*, vol. 52, n°2, pp. 59-64.

Zott C., Amit R., Massa L. [2011] “The Business Model: Recent Developments and Future Research”, *Journal of Management*, vol. 37, n°4, pp. 1019-1042.

Zuckerman E. W. [2000] “Focusing the Corporate Product: Securities Analysts and De-diversification”, *Administrative Science Quarterly*, vol. 45, pp. 591-619.

List of Tables

Table 2.1a: Compounded annual growth rates of principal indicators of top 25 aerospace companies worldwide between 2000 and 2014 (in %) 65

Table 2.1b: Average profitability and payout ratios of world's top 25 aerospace companies between 2000 and 2014 (in percentages except inventory turnover and current ratio) 66

Table 2.1c: Top 20 Aerospace companies' share ownership structures as of mid-2015 67

Table 2.2: Share of top 100 US and non-US contractors for the major US aerospace and defense purchasing departments by dollars obligated in 2013...................................... 71

Table 2.3: Selected commercial aircraft development costs.. 80

Table 2.4: US Industry-Specific Occupational Employment and Wage Estimates in May 2013... 86

Table 2.5a: Subsidies given to Airbus 105

Table 2.5b: Subsidies given to Boeing.. 106

Table 3.1: Launch, first flight and introduction dates of all successful Airbus and Boeing commercial aircraft programs.. 119

Table 3.2: Geographical distribution of Airbus A350 and Boeing 787 outsourcing contracts.. 135

Table 3.3a: Organizational forms and ownership structures of Airbus A350 and Boeing 787 suppliers 136

Table 3.3b: Age distribution of the parent firms of Airbus A350 and Boeing 787 suppliers. 136

Table 3.4: Geographical distribution major sites for Airbus A350 and Boeing 787 contracts.. 137

Table 3.5a: Boeing 787 parts and components manufactured in-house 140

Table 3.5b: Airbus A350 XWB parts and components manufactured in-house................... 141

Table 3.6a: Major Investments of Airbus between 2000 and 2015 159

Table 3.6b: Major Investments of Boeing between 1988 and 2014 160

Table 3.7: Divestments of units, subsidiaries and plants by Airbus (58) and Boeing (26) between 1999 and 2015 164

Table 3.8: Major divestments of Airbus and Boeing in commercial aircraft and parts manufacturing between 1999 and 2015.. 165

Table 3.9: Acquisitions of Airbus (87) and Boeing (48) between 1999 and 2015 167

Table 3.10a: Active joint ventures of Airbus with its partners 172

Table 3.10b: Active joint ventures of Boeing with its partners 174

Table 3.11a: Major design, research and technology centers of Airbus 175

Table 3.11b: Major design, research and technology centers of Boeing 176

Table 4.1: Chronology of unionization, workplace and contract conflicts and related issues at Boeing 197

Table 4.2: Previous and active compensation schemes of Airbus and Boeing for employees and executives 199

Table 4.3: Executed layoffs of Airbus and Boeing.. 206

Table 4.4: Chronology of workplace and contract conflicts and related issues at Airbus..... 210

Table A.1: Value added change in 12 manufacturing industries in specific countries between 2000 and 2010 (in volume) 266

List of Figures

Figure 2.1: The course of world air transport in terms of revenue passenger-kilometers growth, 1950-2012 73

Figure 2.2: Growth in air transport by passengers carried in the US, the EU, China, Brazil and India; 1995-2014 74

Figure 2.3: Year-to-year percentage change in total commercial aircraft deliveries in the world, 1960-2015 75

Figure 2.4: Commercial aircraft deliveries of major manufacturers, 1958-2015 75

Figure 2.5: Number of Airbus and Boeing commercial aircraft deliveries, 1958-2015 76

Figure 2.6: Geographical distribution of total revenue between 2005 and 2014 (10-year total) 77

Figure 2.7: Distribution of Airbus geographical segment revenue between 2000 and 2014 . 77

Figure 2.8: Distribution of Boeing geographical segment revenue between 1991 and 2014. 78

Figure 2.9: The comparison of the composition of US aerospace workforce in 1999 and 2013 88

Figure 2.10: The comparison of the composition of aerospace engineering workforce in 1999, 2013 88

Figure 2.11: Application of NASA funded research on commercial aircraft 100

Figure 2.12: Categorization of government support to commercial aircraft industry 108

Figure 2.13: In service or in development short to medium rage jet aircrafts in the world . 110

Figure 3.1: Length of the development period for new aircraft models of Airbus and Boeing 118

Figure 3.2: Number of patents issued by Boeing and Airbus as current assignees, 2015 included 144

Figure 3.3a: Growth in the number of patents issued by Airbus in top 15 patent groups between 1986 and 2015 146

Figure 3.3b: Growth in the number of patents issued by Boeing in top 15 patent groups between 1986 and 2015 146

Figure 3.4a: Number of patents issued by Boeing and Airbus as current assignees in B64C and B64D subclasses combined between 1964 and 2015 147

Figure 3.4b: Number of patents issued by Boeing and Airbus as current assignees in B64C-003 Wings patent group between 1990 and 2015 147

Figure 3.4c: Number of patents issued by Boeing and Airbus as current assignees in B29C-070 Shaping composites, i.e. plastics material comprising reinforcements, fillers or preformed parts patent group between 1990 and 2015 148

Figure 3.5: Priority country distribution of the patents issued by Airbus and Boeing 149

Figure 3.6a: Research and Development Expenditures of Boeing and Airbus in the commercial aircraft segment as a proportion of commercial aircraft sales 151

Figure 3.6b: Total Research and Development Expenditures of Boeing and Airbus in the commercial aircraft segment, in current US$ 152

Figure 3.7a: Total Research and Development Expenditures of Boeing and Airbus as a proportion to total sales 152

Figure 3.7b: Total R&D Expenditures of Boeing and Airbus, in current US$ 152

Figure 3.8a: Capital Expenditures of Boeing and Airbus in the commercial aircraft segment as proportion to commercial aircraft sales 154

Figure 3.8b: Total Capital Expenditures of Boeing and Airbus in the commercial aircraft segment, in current US$ 154

Figure 3.9a: Gross Plant, Property and Equipment Expenditures of Boeing, current US$.... 155

Figure 3.9b: Gross Plant, Property and Equipment Expenditures of Airbus, current euros . 156

Figure 3.10: Floor Space of Boeing from 1995 to 2015 156

Figure 3.11: Airbus Total Capital Expenditures by country 157

Figure 4.1a: Total workforce of Airbus and Boeing 191

Figure 4.1b: Total commercial aircraft workforce of Airbus and Boeing............................. 192

Figure 4.2: Commercial aircraft employees per aircraft delivered at Airbus and Boeing 192

Figure 4.3: Personnel costs as a proportion of total costs at Airbus and Boeing 193

Figure 5.1: Selected Figures of Nonfinancial Corporations in the US (Table F.102) as a proportion to total corporate profits before tax, 1946-2013....................................... 225

Figure 5.2: Operating Cash Flow as a proportion of Sales at Airbus and Boeing 227

Figure 5.3: Year-to-year change in long-term debt for Airbus and Boeing, current US$ in bill. 229

Figure 5.4a: Mean Dividends of US S&P500 (427) and European S&P350 (298) companies 230

Figure 5.4b: Mean Share Repurchases of US S&P500 (399) and European S&P350 (302) companies 230

Figure 5.4c: Mean Dividends + Share Repurchases of US S&P500 (399) and European S&P350 (302) companies 230

Figure 5.5a: Share repurchases of Airbus and Boeing, current prices.................................. 233

Figure 5.5b: Dividend payments of Airbus and Boeing, current prices 233

Figure 5.5c: Total Payout of Boeing and Airbus (dividends + share repurchases), current prices 233

Figure 5.5d: Dividends per share of Boeing and Airbus, current prices 233

Figure 5.6a: Airbus shareholding concentration between 2004 and 2015 236

Figure 5.6b: Boeing shareholding concentration between 2004 and 2015 236

Figure 5.7a: Types of Airbus shareholders with their proportion in December 2015, in % .. 238

Figure 5.7b: Major shareholders (>1%) of Airbus in December 2015, in % 238

Figure 5.8a: Types of Boeing shareholders with their proportion in December 2015, in % . 239

Figure 5.8b: Major shareholders (>1%) of Boeing in December 2015, in %........ 239

Figure 5.9a: Proportion of stock options/awards granted to Airbus and Boeing CEOs 243

Figure 5.9b: Number of Airbus and Boeing CEO stock options/performance shares executed/vested........ 243

Figure 5.10: Total CEO remuneration for Airbus and Boeing 244

Figure A.1a: Manufacturing employment as a percentage of total employment in selected countries, 1990-2012........ 262

Figure A.1b: Percent Change in Manufacturing Jobs in Selected Countries, 2000-2012 263

Figure A.2a: Manufacturing value added as a percentage of country GDP, 1990-2013....... 264

Figure A.2b: Manufacturing value added, constant 2005 US$, 1997-2013 264

Figure A.2c: Percentage change in manufacturing real value added (US adjusted), 2000-2010 265

Figure A.3: Merchandise Trade Balance of a selected group of economies in a group of advanced technology products, by commodity........ 267

Figure A.4: Gross fixed capital formation (Percentage of GDP) 268

Figure A.5: Aerospace employment in the US and Europe, 1992-2012........ 268

Figure A.6a: Aerospace Manufacturing Output in Airbus' Home Countries and Italy (2010=100) 269

Figure A.6b: Value of US Aerospace Manufacturing Shipments (2009 = 100)........ 269

Summary in French – Résumé en français

Cette thèse examine les interconnections entre les trois principaux éléments de l'activité productive de la firme dans le capitalisme moderne, à savoir la stratégie d'entreprise, la structure organisationnelle et l'engagement financier (*financial commitment*). Elle s'appuie sur l'étude des cas des deux plus grandes firmes du secteur aéronautique au niveau mondial, Airbus et Boeing. L'activité productive de chaque firme est analysée à partir du cadre original « modèle d'affaires (*business model*) / modèle productif de l'intégration de systèmes » développé dans le premier chapitre. Les transformations récentes des stratégies d'entreprise, des relations industrielles et des activités financières des firmes dans les économies développées sont brièvement abordées avant de mobiliser le cadre analytique dans une perspective historique et comparative. En adoptant une approche basée sur le récit détaillé dans le temps long des stratégies des deux firmes et leur mise en comparaison, l'étude de la deuxième partie s'inscrit dans la lignée des travaux de Chandler (1962, 1977), de Penrose (1959, 1960) et, plus récemment, de Froud et al. (2006) et de Lippert et al. (2014).

À travers cette approche, la thèse met aussi en évidence les dynamiques industrielles qui caractérisent la phase de restructuration plus récente du secteur aéronautique. Ce processus est généralement lent mais également profond et irréversible comme dans le cas de la Russie et des Pays-Bas où les deux dernières décennies ont été marquées par leur incapacité à retrouver leur précédent niveau de production.

Contrairement à la littérature analysante la technologie qui considère l'intégration de systèmes comme une nouvelle forme de capacité utilisée pour développer et produire des biens ayant le caractère de « *systems* » (c'est-à-dire des biens plus coûteux, plus complexes et exigeant la collaboration d'un grand nombre d'organisations, Hobday et al., 2005; Prencipe et al., 2003), cette thèse examine l'intégration de systèmes comme un modèle productif / modèle d'affaires qui a des caractéristiques à la fois stratégiques, organisationnelles et financières. La forme prise par l'intégration de systèmes dans les deux firmes au cours des deux dernières décennies définit non seulement leur réorganisation en termes de R&D et d'activité productive, mais elle entraîne également d'importantes conséquences financières et organisationnelles. En s'appuyant sur l'approche des modèles productifs issue de la Théorie

de la Régulation et sur la théorie de l'entreprise innovante développée par W. Lazonick, ce travail identifie les stratégies distinctes d'intégration et de désintégration suivies par Airbus et Boeing ainsi que leurs conséquences sur l'amélioration ou la dégradation de leurs capacités productives. Il souligne le rôle important joué par les nouvelles pratiques poursuivies par les firmes en termes de finance et d'organisation du travail dans le cadre de la mise en place de l'intégration de systèmes.

L'apport principal de cette thèse est de montrer qu'une analyse strictement basée sur les stratégies commerciales et la technologie est insuffisante pour rendre compte des orientations choisies dans les activités productives. Pour cette raison, la thèse propose le cadre analytique fondé sur les modèles productifs / modèles d'affaires qui permet non seulement d'analyser les stratégies poursuivies en termes de technologie et d'organisation de la chaîne de valeur mais également en termes d'organisation industrielle et d'engagement financier. Ce cadre intègre ainsi des éléments financiers et organisationnels dans l'étude des processus d'innovation dans leur ensemble.

Les résultats montrent qu'il existe une corrélation forte entre l'externalisation massive, la financiarisation et les relations d'emploi conflictuelles. Externalisant 70% de son dernier programme innovant B787 et voulant garder sous contrôle les dépenses de R&D et d'investissement, Boeing exerce une pression sur ses employées par des licenciements récurrents, des relocalisations, des suppressions à la fois de poste et d'avantages postérieurs à l'emploi. La sécurité de l'emploi est devenue la préoccupation principale de la main-d'œuvre et la réorganisation de la R&D intensifie les tensions entre la direction et les employés. Alors que la firme vise à réduire ses dépenses par le recours à l'externalisation et le durcissement des conditions de travail, elle a dans le même temps étendu ses pratiques en termes de création de valeur actionnariale par l'augmentation des dividendes et des rachats d'actions ainsi que par les stock-options accordées aux directeurs et employées dont le rang dans la hiérarchie est élevé. Ainsi les pratiques d'extraction de valeur liées au processus de financiarisation sont profondément enracinées dans la firme. Par rapport à Boeing, Airbus a suivi jusqu'à récemment une stratégie équilibrée permettant d'atténuer les intérêts conflictuels. Bien qu'elle ait externalisé 50% de son dernier programme d'avion commercial A350 et cédé certaines divisions opérationnelles dans le cadre de programmes de réduction de coûts, la tension avec la main-d'œuvre et la distribution massive de la valeur actionnariale ont jusqu'ici été maîtrisées par la firme. Toutefois, son discours et ses pratiques récentes en termes de distribution de la valeur actionnariale tendent à montrer que la firme est sur la voie d'une stratégie plus financiarisée. Les inquiétudes de la main d'œuvre quant à la sécurité de l'emploi ont également augmenté.

L'analyse menée tout au long de cette thèse tend à montrer que les stratégies menées par Boeing et Airbus en termes d'intégration de systèmes peuvent avoir des effets nuisibles sur leur position concurrentielle à long terme, et elles ne sont pas à l'abri d'effets négatifs liés à la financiarisation et à la détérioration des pratiques d'emploi. Plus généralement, l'évolution future de leurs activités aura des répercussions majeures sur le secteur aéronautique dans leur(s) pays d'origine.